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ECOSYSTEM SERVICES AND THE CENTRAL TEXAS GREENPRINT FOR GROWTH: VALUING NATURE THROUGH COLLABORATIVE LAND CONSERVATION

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ECOSYSTEM SERVICES AND THE CENTRAL TEXAS GREENPRINT FOR GROWTH: VALUING NATURE THROUGH COLLABORATIVE LAND CONSERVATION

by

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Report

Presented to the Faculty of the Graduate School

of the University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Masters of Science in Community and Regional Planning

The University of Texas at Austin

December 2010

Dedication

To my family – Kathy, Henry, George and Luci for your support, patience, sacrifice, and love.

ECOSYSTEM SERVICES AND THE CENTRAL TEXAS GREENPRINT FOR GROWTH: VALUING NATURE THROUGH COLLABORATIVE LAND CONSERVATION

by

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The University of Texas at Austin, 2010

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This project explores the potential for integrating an ecosystem service approach with the Central Texas Greenprint for Growth process, a continuing and active stakeholder supported voluntary conservation effort The report provides an overview of the Greenprint process, ecosystem services, and the participatory stakeholder method of social network analysis or mapping. Each of these methods may be used to explore opportunities to enhance the collaborative land conservation planning activity in Central Texas. Conservation goals identified in the Greenprint process are evaluated in terms of ecosystem service and methods for measuring more complete environmental value can be identified. This evaluation focuses on three out of the six goals that the stakeholders have identified as having importance: *protect water quality and quantity, preserve farms and ranchlands,* and *protect cultural resources.*

Community-based environmental planning or adaptive management processes such as the Greenprint process requires effective communication methods to address complex issues

among diverse stakeholders. Social network mapping and analysis are illustrated as a method to evaluate how stakeholders communicate information about ecosystem services. A limited social network analysis is conducted as a pilot study with a stakeholder group in Bastrop, Texas. Natural resource professionals have used social network analysis to understand the structure of relationships and the pathways of communication in community planning processes. I will review this method and its potential for application. Through questionnaires, data gathered at a stakeholder meeting and is used to develop a preliminary social network matrix to demonstrate the method. It is envisioned that the report would advance understanding of how an ecosystem service approach can enhance an active ecological planning process and landscape scale conservation.

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Executive Summary

Communities in Central Texas initiated the Central Texas Greenprint process in 2007 to address concerns over loss of open space, farmland and watersheds. Population is increasing steadily with rapid rates in high growth areas such as Hays County, which is projected to grow in population by 210% from a 2000 baseline of 97,600 to 302,800 in 2030 (http://www.hillcountryalliance.org). Additionally, Texas leads the country in the number of lost acres of farmland. According to a recent report published by the National Resource Conservation Service (http://www.nrcs.usda.gov/technical/NRI/), Texas has lost more agricultural acreage (2,869,600 acres) and prime agricultural acreage (1,093,700) from 1982 to 2007. Many of the counties experiencing the greatest change are near urban areas including Central Texas, where the need for agricultural production is the greatest. Water will be an increasing problem as each of the State Water Planning Regions in Central Texas project shortfalls in water availability by 2060. Managing and conserving landscapes, ecosystems, and watersheds is a considered a key component in maintaining a regional identity, as well as addressing these crucial land use questions. Open space is not only important to the region's heritage and sense of place, but provide valuable benefits to communities, or ecosystem services.

There are many reasons why regional, landscape-scale conservation is an inherently difficult process. Fractured and overlapping governing jurisdictions, lack of political

will, and competing economic priorities are paramount among these reasons. Yet landscape-scale (watersheds, ecosystems, bioregions, scenic corridors, ranch and farmlands) conservation areas provide many economic benefits or ecosystem services, to communities (MEA, 2005; Norgaard, 2007; Ruhl, 2005; Steiner, 2008). Few regulatory or legal mechanisms are available to conserve landscape-scale regions. The federal and equivalent state mechanisms that are available such as the National Environmental Policy Act (NEPA), the U.S. Clean Water Act (CWA), federal and State of Texas Threatened and Endangered Species regulations, the Texas Water Quality Integrated Report are relevant only when a threatened or endangered species is identified, or when a pollutant is detected in a water source. Primary environmental laws protect against specific and limited threats, rather than providing a systematic mechanism for preserving ecosystems. The current regulatory system focuses on minimizing threats to individual components of a landscape, rather than maximizing and enhancing the cumulative and integrated benefits of a landscape or ecosystem as a whole. Therefore, attempts to encourage landscape-scale conservation often take the form of voluntary partnerships and incentive based actions, such as conservation easements. Many of these partnerships achieve a degree of success, however competing economic interests and development are a continuing threat to conservation.

The Central Texas Greenprint for Growth (Trust for Public Lands, 2009) and its predecessor the Travis County Greenprint for Growth (Trust for Public Lands, 2006) are examples of such a local conservation action and voluntary partnership or community-

based environmental plan. Together the two Greenprint projects cover 4 out of the 5 counties that are part of the Envision Central Texas Region. Similar Greenprinting processes can be found in other regions throughout the country. The Upper Neuse Clean Water Initiative Conservation Plan of Central North Carolina, and the Litchfield Hills Greenprint of Northwestern Connecticut, are two additional Greenprint initiatives that will be reviewed for potential insights and applications.

An initial step of the Greenprinting process is the involvement of stakeholders in identifying regional conservation priorities. Once conservation priorities of the stakeholders are identified, the next step is to construct maps that identify open space and landscapes that if conserved, help support these conservation goals. A proposed next step is to include the identification, analysis, and prioritization of the ecosystem service benefits that are associated with this landscape-scale conservation effort. Integrating an ecosystem service approach can enhance Greenprinting by assessing a value and providing logical reasons for taking action. In addition the identification of ecosystem services may strengthen regional and regulatory planning efforts and regulatory actions.

The purpose of this report is to understand the potential for integrating an ecosystem service approach with the Central Texas Greenprint for Growth process, a continuing and active stakeholder supported voluntary conservation effort. In chapter 2, I will provide and overview of the Greenprint process and the application of the Greenprint in Central Texas Greenprint. For the purpose of learning from other experiences, Chapter 3 presents

two reviews of mature Greenprints from other regions that have been in place for at least 3 years. Chapter 4 presents background information and a review of the theory and practice ecosystem services. Social network analysis is explored in chapter 5, as a means of understanding the communication, networks and relationships within a collaborative environmental management process. Chapter 6 reports results from an exploration of the use of social network mapping in an on-going collaborative planning effort and offers a potential framework for integrating ecosystem services and the Greenprint process. The remainder of this chapter lays out the context of conservation efforts of the Central Texas Greenprint for Growth.

Each of these methods may be used to enhance the collaborative land conservation planning activity in Central Texas. The conservation goals identified in the Greenprint process will be evaluated in terms of ecosystem services. Also we can begin to identify ways to measure value. This evaluation will focus on three goals that the stakeholders have identified as having importance: *protect water quality and quantity, preserve farms and ranchlands,* and *protect cultural resources* (Trust for Public Land, 2009).

Additionally, as with many community-based environmental planning or adaptive management processes (Ernstson et. al, 2008; Naorgaard, 2009; Mandarano, 2008), the success of the Greenprint process partially lies in its strength and ability to communicate with, and address complex issues among diverse stakeholders. Social network mapping and analysis will be illustrated as a method to evaluate what stakeholders know about

ecosystems services and how they communicate information. Natural resource researchers and practitioners are increasingly using social network analysis to understand the structure of relationships and the pathways of communication in community planning processes (Provan et al. 2005; Prell et al. 2009). I will review this method and its potential for application. A limited social network analysis will be conducted with a stakeholder group in Bastrop, Texas as a pilot study. Data will be gathered at a stakeholder meeting and I will attempt to develop a preliminary social network matrix to demonstrate the method. The report aims to advance our understanding of how an ecosystem service approach can improve ecological planning processes and landscape scale conservation.

Research Question

In short, the research questions may be stated as follows:

How might an ecosystem service approach enhance the Central Texas Greenprint process?

and

How might a social network analysis improve stakeholder communication?

Overview

Several recent global assessments and indicators report the continuing and severe decline of the world's natural resources and impacts on ecological systems. According to the

2010 Living Planet Report (World Wildlife Fund, 2010) using the latest available data from 2007, annually the global society is exceeding biocapacity by 50%, by consuming 1.5 times the world's natural resources that are produced each year. Since 1970, we have seen a 30% decline in the world's biodiversity measured by the total populations of species. Additionally 60% of the world's ecosystem services are degraded or being unsustainably managed according to the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2006). Water resources and related ecosystem benefits are in serious decline in many regions. Local water quality and availability have been impacted are numerous by growth and development. A recent Austin-American Statesman (October 14, 2010) article with the title, *"Travis County mulls temporary ban on development relying on Trinity water. County officials say wells over the aquifer are endangered,"* reports yet another threat to local water supply. Moreover, downstream communities, bays, estuaries, and ecosystems feel the impacts of increasing water use in Central Texas (Johns, 2004).

The Central Texas and Travis County Greenprint process is a regional response to the increasing stresses on our ecosystems and landscapes. It is an attempt to collect data, and provide a framework for local and regional conservation strategies. The focus of the study is the five county Central Texas region supported by Envision Central Texas. However, lessons learned could be applicable to other Greenprinting plans and landscape-scale plans throughout Texas, the United States, and elsewhere.

In Central Texas, there are several programs and conservation plans that promote landscape scale conservation. Several activities in the region are being implemented with ecosystem service theory specifically or implicitly in mind and include, the City of Austin Watershed Protection Lands, and the Sustainable Sites Initiative implemented by the Ladybird Johnson Wildflower Center. Other related landscape scale regional initiatives include the Barton Creek/Edwards Aquifer Regional Water Quality Protection Plan (www.waterqualityplan.org), Hays County Habitat Conservation Plan (http://www.hayscountyhcp.com/), Lost Pines Habitat Conservation Plan (http://www.co.bastrop.tx.us/site/content/lostpineshabitat), and the Balcones Canyonlands Conservation Plan (http://www.co.travis.tx.us/tnr/bccp/default.asp).

"The Central Texas Greenprint for Growth: A Regional Action Plan for Conservation and Economic Opportunity" (http://www.envisioncentraltexas.org/) was published in October 2009 by Envision Central Texas (ECT), Capital Area Council of Governments (CAPCOG) and The Trust for Public Land (TPL). Using available GIS data, the Central Texas Greenprint serves as a template for identifying conservation priorities in the five county ECT region. The report is a result of GIS and land use analysis, conversations, stakeholder meetings, interviews and assessments that were conducted between May

2008 and June 2009. An outcome of the Greenprint process was the identification of six overarching priority conservation goals:

- Protect Water Quality and Quantity
- Preserve Farms and Ranchlands
- Enhance Recreation Opportunities
- Protect Sensitive Ecological Areas
- Protect Cultural Resources and Historic Sites
- Protect Scenic Corridors and Viewsheds

Landscapes, watersheds, foodsheds, and ecosystems provide economic benefits to humans in the form of ecosystem services. The importance of each of these region-scale planning systems is considered in the Greenprint goals and priorities. The concept of ecosystem services can complement the Central Texas Greenprint by assessing values or identifying economic priorities for the conservation goals. Each of the identified conservation goals for the Central Texas Greenprint can be framed in terms of associated ecosystem services. With an emphasis on integrating economy and the environment, the Central Texas Greenprint Plan provides the framework for an ecosystem service approach. Additionally, Greenprint stakeholders have identified green infrastructure, or a strategic approach to using nature to provide support functions to human communities, as an important concept worthy of advancing. However, at this time a direct ecosystem services approach has not been used to prioritize or value ecosystem benefits.

Ecosystem service theory and application is not without limitations (Lant et. al, 2008; Norgaard, 2009; Ruhl et. al, 2007). Economic modeling of benefits is often challenged by lack of available data. Also there are few examples of integrating ecosystem services into regional landscape planning processes and within environmental regulatory systems. However an ecosystem service approach can be a powerful tool to:

1) Systematically identify and prioritize the benefits that nature offers that are not commonly counted in our regional economic and growth models.
2) Encourage thoughtful stakeholder participation and information exchange; and provide a framework for supporting conservation efforts.
3) Provide a way to consider conservation efforts and the value of nature in municipal activities such as strategic planning, budgeting and financing.

This report will explore the connections between ecosystem services and the Central Texas Greenprint project, with a goal of highlighting the benefits of this integrated approach. Each of the conservation goals will be evaluated in terms of ecosystem services and the potential to use an ecosystem service approach as a unifying planning approach for addressing the stated conservation goals. The process will include two components:

1) Propose strategies for integrating ecosystem services and greenprinting. The Central Texas Greenprint conservation goals will be defined in this report in terms of the categories of ecosystem services identified by the Millennium Ecosystem Assessment (MEA) and related assessments. I will explore an ecological planning approach for integrating the concept of ecosystem services within the Greenprint planning process. The identified conservation goals of the Central Texas Greenprint will be compared to and defined in terms of ecosystem services as defined by the MEA (provisioning services, regulatory services, supporting services and cultural services). The outcome will be an assessment and recommendations for implementing an ecosystem service approach.

2) Explore the basic concepts of social network analysis as a pragmatic process for understanding stakeholder involvement and connecting resources. Social network analysis is a useful method for analyzing how knowledge, information and resources are transferred between individuals and organizations, principally in a voluntary or collaborative management process. As a method, social network analysis can be utilized to map interactions and sharing of knowledge between experts, organizations, advocates, and various stakeholders within a community based environmental program, such as the Central Texas Greenprint process. Outcomes may include improved insight into the methods of communication between stakeholders; and an understanding of how data, complex concepts and local knowledge is transferred between

stakeholders. Specifically, social network analysis considers the number, strength and quality of communications between stakeholders within a community-based program. The method attempts to answer the questions "Who talks to whom?" and "Who listens to whom?"

Both Greenprinting and ecosystem services are systematic approaches toward addressing the complex issues associated with ecological or landscape planning. These processes propose methods of planning and managing in a situation where regulations, rules or administrative plans may not adequately support conservation or ecological protection. Identification of additional voluntary tools and incentives may be synergistic to regulatory and administrative tools in meeting conservation goals. The objective of this report is to consider the potential for integrating the concept of ecosystem services into the Greenprint process; and to understand the role of stakeholders in regional ecosystem service management in relation to the current regional planning processes, such as the Greenprint plans, Habitat Conservation Plans (Hays County, Lost Pines, Balcones Canyonlands), City of Austin Watershed Protection Lands and the Regional Water Quality Protection Plan.

Chapter Two: A Greenprint for land conservation in Central Texas

What is Greenprinting?

Greenprinting is a process that is employed by conservation organizations and local governments to address a multitude of connected environmental and ecological issues that are related to land use. The Greenprint process was developed by the Trust for Public Lands (TPL), and the National Association of Counties to provide a toolkit for localities for guiding growth sustainably. The TPL methods were described in a series of publications, *Greenprint for Growth, Vol. I-III* (Trust for Public Land, 2001-03) and emphasized a process for developing a regional conservation vision, supporting the process with resources and identifying funding options, and strategically acquiring and managing land to meet the conservation priorities. The Trust for Public Lands (TPL) has adopted the Greenprint process and the associated tools as a primary method for promoting conservation, especially in regions that are experiencing rapid growth and development. TPL defines Greenprinting as "a strategy that emphasizes land conservation to ensure quality of life, clean air and water, recreation, and economic health (Trust for Public Land, 2002)." The concept of Greenprinting is a familiar one, and can be traced to Ian McHarg's seminal publication, "Design with Nature" (1969) and the overlay process of identifying ecologically sensitive landscapes. Other organizations and agencies employ similar and overlapping methods and have developed plans and implemented programs in other communities. The Conservation Fund (http://www.greeninfrastructure.net) supports the Green Infrastructure planning process,

while the American Farmland Trust (http://www.farmland.org) has produced numerous studies of regional farmland conditions and cost of services to local communities using similar processes.

Greenprinting uses Geographical Information Systems (GIS) to map community or regional conservation priorities. The process is interactive and incorporates GIS data to support community goal setting and priority ranking, or weighting. Central to the Greenprinting process is the identification of community conservation priorities and interactive map building. This application of GIS modeling and mapping technology integrated with local conservation goals provides input for communities to make strategic, objective decisions about land conservation, infrastructure, and development priorities.

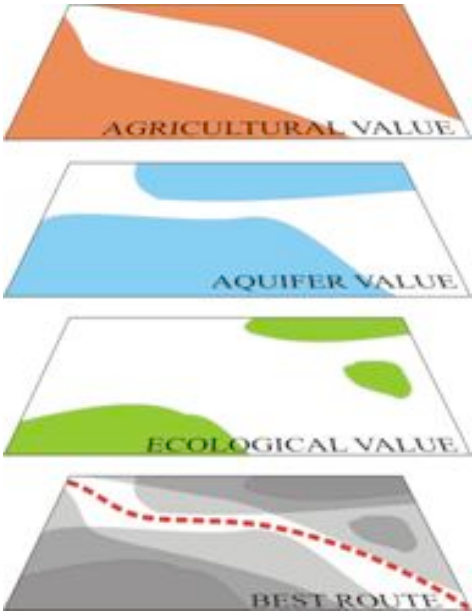


Figure 1. The overlay process from Ian McHarg's, "*Design with Nature*" (1969).

The Central Texas Greenprint program has employed the following steps to establish a community-based planning process, to meet the needs of the region:

1. Identify conservation goals for each county
2. Convert conservation goals into mappable criteria
3. Create maps that reflect each county's goals
4. Weight goals according to community priorities
5. Create overview maps that reflect each county's priorities & identify areas meeting multiple priorities

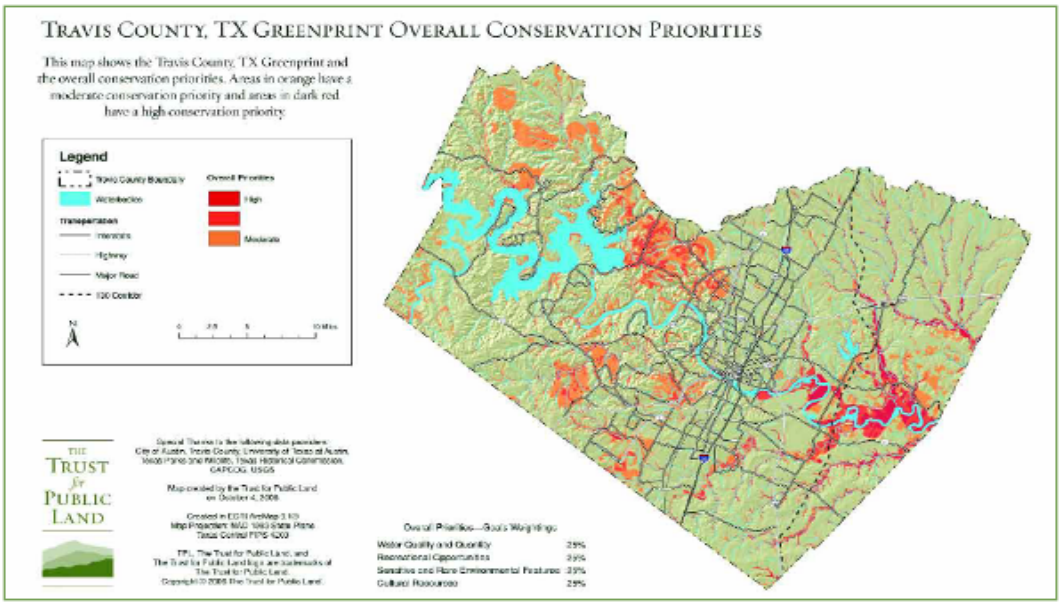


Figure 2. A conservation priority map developed with stakeholder input from "The Central Texas Greenprint for Growth"(Trust for Public Land, 2009).

An example of a community conservation priority that is common among many Greenprint projects is preserving water quality, and protection of watershed buffers is a key conservation strategy. As the protection of watershed buffers is considered to be one of the most important management strategies that can be employed to meet the multiple objectives of a strong ecologically-based watershed plan (Schueler, 2000), GIS layers can be adjusted to illustrate multiple protection scenarios. Protection of sensitive buffer zones will protect water quality by helping to minimize run-off, while the natural vegetation in buffer zones provides valuable natural pollutant controls. Additionally, maintaining wide buffers can maximize additional ecosystem services such as: habitat protection, greenway and trail access, preservation of native plants and pollination services, and carbon sequestration services (Daily, 1997; Postel and Thompson, 2005). Community input can be incorporated to help set standards for buffers and to help decide on appropriate sizes to meet as many of the community goals as possible. An integrated ecosystem service approach can help place a value on the buffers (Schuller, 2000), either by identifying and communicating the potential value to the community, or by calculating an actual monetized amount (Postel and Thompson, 2005).

History and background of Greenprinting

Early adopters applied the concept in King County, Washington (Trust for Public Land, 2005). More than 40 regions followed and adopted components of the Greenprint process, including the Upper Neuse River, North Carolina (http://www.ctnc.org); Litchfield Hills, Connecticut (http://www.hvatoday.org); Galveston, Texas; and Travis

County, Texas and the Central Texas Region (http://www.tpl.org/tier3_cd.cfm?content_item_id=20161&folder_id=3130). While the basic process of obtaining community input, producing maps, and completing an initial analysis based on the identified conservation goals is common between the various regional efforts, methods for long-term support and implementation of the Greenprint process vary from region to region. While some have been initiated and adopted within the local government, other projects are completely grassroots efforts. In some regions, the Greenprint projects have resulted in bond elections and other actions to support land conservation efforts. Most projects involve a mix of stakeholders and methods of implementing conservation.

History and background of Greenprinting in Central Texas

In Central Texas, four counties of the Envision Central Texas region (Bastrop, Caldwell, Hays and Travis) participated in the Greenprint planning process. The Travis County Greenprint (The Trust for Public Lands, 2006a) was the first effort at Greenprinting in the region. Following the completion of that effort, Central Texas Greenprint Project (The Trust for Public Lands, 2009b) was initiated in 2007 for Bastrop, Caldwell and Hays Counties. The project was led by Trust for Public Lands, Capital Area Council of Governments and Envision Central Texas. Numerous organizations and stakeholders participated in identifying conservation priorities, planning, providing input and producing Greenprint maps. Input and data were collected through inventories of existing resources, parks, and open space; interviews with key stakeholders; and public

meetings. These activities led to the identification of conservation goals and priorities, and the production of Greenprint maps.

As a community based environmental project, the Central Texas Greenprint for Growth provides a roadmap for local agencies and organizations for moving forward with land use and conservation plan. Trust for Public Lands (2009) defines the Central Texas Greenprint for Growth as "*a tool for balancing sustainable conservation goals with the infrastructure needs of our rapidly urbanizing region (Trust for Public Land, 2009).*" At this time, there is no overall commitment to strategically implement the plan. However, various local governments and organizations in each county have identified local conservation priorities and strategies for potential implementation. The process is at a critical stage as maps have been generated and reports produced, but the path to next steps and implementation phases remains somewhat unclear. Envision Central Texas put organized volunteer advisory committees such as the Green Infrastructure Committee, to implement the program and develop recommendations. Along the way they are developing cases studies that will be used to highlight best practices. As the next implementation phases continue to be developed, it may be possible to consider integrating an ecosystem services approach into the Greenprint process, providing additional incentives for implementing conservation strategies. Enhanced Greenprint maps could identify ecosystems services at the individual project level, county or region level dependant upon the available data. For instance it may be possible to identify land that has the potential for increasing in-stream flows, or regional drinking water source.

Defining a conservation vision and identifying priorities

The Greenprint process relies heavily on strong community and stakeholder support and participation, to define the vision of the project and develop a set of conservation priorities that can be adopted for the region. Committees, focus groups and community meetings are employed to obtain input and continued participation and buy-in. The GIS data and interactive mapping process is an integral process for identifying and setting community priorities.

Once the community defines and agrees upon the conservation priorities, they are then weighted or ranked by stakeholders, through a facilitated participatory process. Data sets are identified and used to interactively produce the maps that illustrate the conservation priorities. A community is now armed with knowledge of what areas are most beneficial for conserving water, agricultural lands, habitat, recreation areas or those things that fulfill their conservation vision. The next steps in the Greenprint process are to set goals, identify resources and create a strategy for obtaining or protecting land to maximize conservation and meet the goals. Greenprint stakeholders and advisory committees can introduce an ecosystem service approach to enhance the Greenprint process. Greenprint priorities and implementation strategies can be defined in terms of ecosystem services.

Conservation goals in Central Texas

In Central Texas, the community conservation priorities were set during a series of consensus building meetings (during 2008-2009) throughout the region that were open

and to decision makers and the public. During this process participants were encouraged to work toward common goals by consensus, and to develop a set of unique community and regional priorities specific to the region and applicable on many scales- from an individual section of land, to a county, to the region. The consensus priorities identified were:

- *Protect water quality and quantity*
- *Enhance park and recreational opportunities*
- *Protect sensitive ecological resources*
- *Protect cultural/historic resources*
- *Protect scenic corridors*
- *Conserve farm and ranch land*

Once the priorities were determined, each was ranked according to the number of people who considered it to be the most critical priority (Figure 3).

Then specific mappable criteria that support each of the specific goals were identified- and maps were created using available GIS data. By combining (or "overlaying") the priority areas identified to meet each conservation goal, we can identify and highlight areas where multiple goals overlap. Maps can identify the intersections of sensitive habitat, agricultural lands, and critical water features such as rivers, streams, and recharge features (Figure 2).

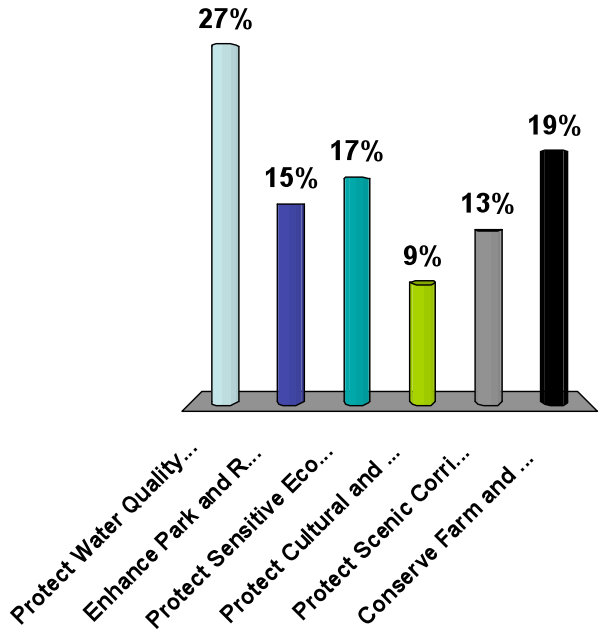
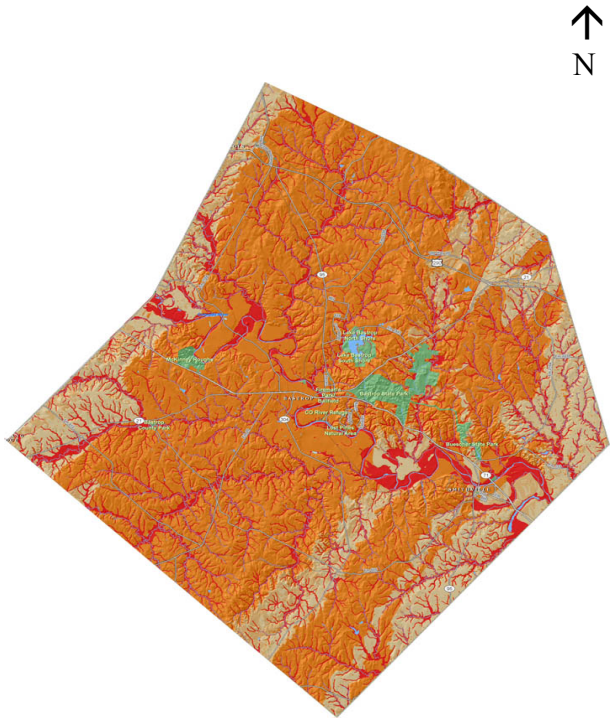


Fig. 3. This graph reflects the consensus community rankings for the top conservation priorities for the Central Texas Greenprint Region (from Envision Central Texas presentation on October 27, 2010).

The following maps illustrate the results of the collaborative, stakeholder process. They were developed with the criteria selected during the stakeholder process. For each critereia, specific mappable features, supported by available GIS data, were identified for each priority. The conservation priorities considered at this time are: water quality and quantity, farm and ranchland preservation, and parks and recreation enhancement.

Water quality & quantity

Priority mappable features for preserving water quality and quantity	
Rivers, Streams, Creeks	Waterbodies
Aquifers/Recharge Zones	Floodplain
High Quality Woodlands	Steep Slopes
Karst Features	Native Prairie
Alluvial Soils	Springs

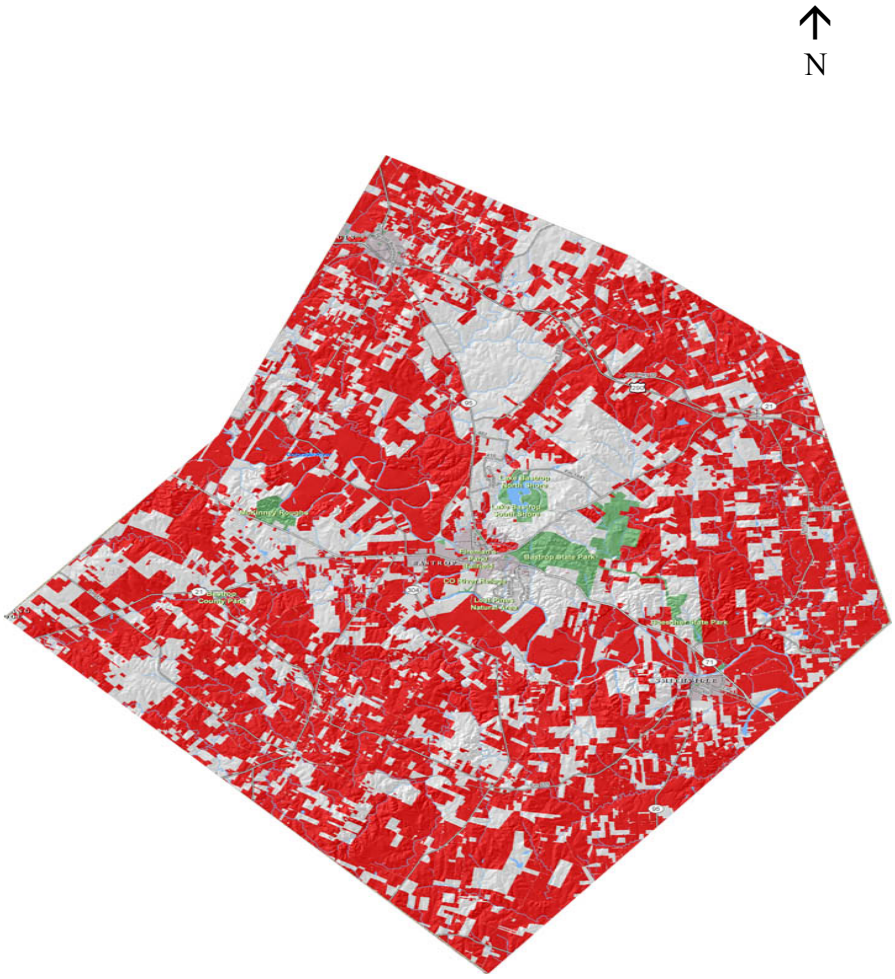


Priority features
High
Moderate
Low

Figure 4. Map of water quality and water quantity conservation priority features for Bastrop County, Texas. (Presentation by Envision Central Texas staff, Diane Miller, October 28, 2010).

Farm and ranchland priorities

Priority mappable features for preserving water quality and quantity	
Agricultural Lands	Ranch Lands



Priority features
Agricultural
Non-Agricultural

Figure 5. Map of farm and ranchland conservation priority features for Bastrop County, Texas (Presentation by Envision Central Texas staff, Diane Miller, October 28, 2010).

Park and recreation priorities

Priority mappable features for enhancing parks and recreation	
Greenspace	Adjacent to Existing Parks
Riparian Corridors	Park Equity Analysis
Trail Connectivity	Access to Waterways
Floodplain	Parks in unincorporated areas, in I35 corridor and along rivers

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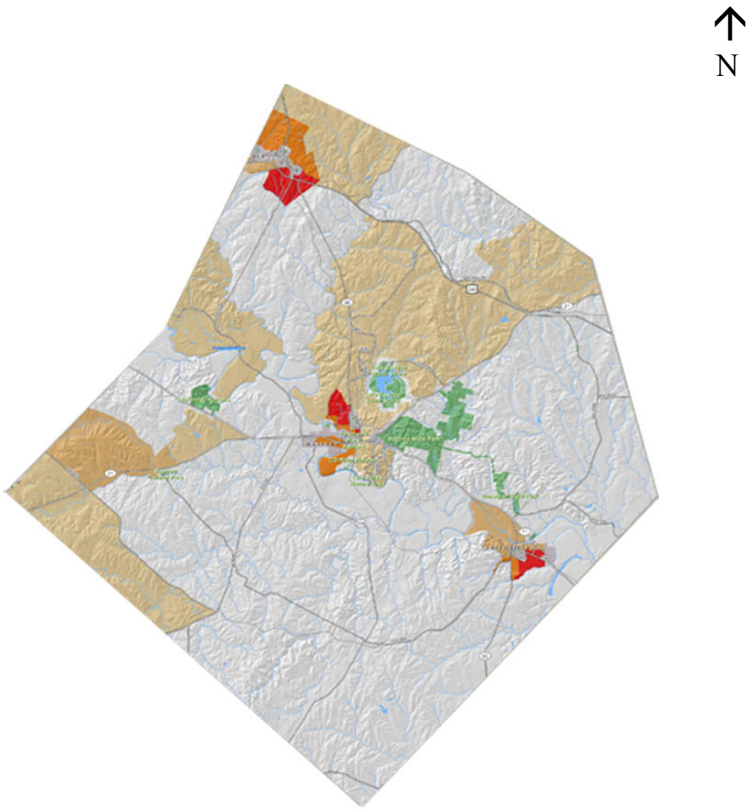


Priority features
High
Moderate
Low

Figure 6. Map of park and recreation enhancement priority features for Bastrop County, Texas. (Presentation by Envision Central Texas staff, Diane Miller, October 28, 2010).

A process led by stakeholders

The role of stakeholders is critical in all community-based initiative, and the Greenprinting process is no different. Our human community cannot help being intricately connected to nature and ecological systems. We live, work, and play where we do, and enjoy our surroundings because of the natural resources that are available. The Greenprint process leads communities to make the connections between ecological and social systems and make critical decisions to support community and ecological needs. The issues identified in the Greenprint process transcend political and administrative jurisdictions and address priority concerns that involve multiple governing agencies, regions, ecosystems, and users. As there are no current organizations or agencies that exist that govern all of these issues, stakeholder involvement is not only an attractive idea, but also a critical and necessary one.

The Greenprint model encourages a collaborative process. As the process matures, the roles of stakeholders vary and evolve. In the Greenprint model, the initial community sponsors work with the Trust for Public Lands to define the scope and objectives of the project and establish the administrative guidelines such as budgeting and work processes. While this varies from region to region, the initial collaborators tend to be organizations that have resources dedicated to land conservation and supportive organizational mission. Environmental groups, local agencies, planning organizations and land trusts are some of the common organizing partners. The direction of the Greenprint process and eventual

implementation will be a function of the makeup of this initial collaboration, and whether they have the resources and authority to support the process.

As a collaborative process, an issue that should be considered in the Central Texas Greenprint process is that of equity and quality consensus. Effective and fair collaboration is a complex and challenging process that has been addressed by many researchers and advocates (Margerum, 2002; Innes and Booher, 1999). Consensus building around Greenprinting and ecosystem service issues will require care and planning to assure that representative voices heard, and that the marginalized viewpoints have opportunity to provide input (Ernston, et. al., 2008; Prell, et. al., 2009)

As the process develops and the critical administrative functions such as budgets and timelines are put into place- the stakeholder pool is broadened to include a diverse set of stakeholders to participate in shaping the priorities, goals, and outcomes. Attention to the participatory design can allow for alternative communication methods to include those that would not normally have a voice in the process due to time or economic limitations.

Participate in priorities and goals

Once Greenprint administrative structure is determined, a broad group of stakeholders participate in the process to identify and set the conservation goals. A broader and larger stakeholder group makes for a more valid priority setting process and leads to more support for the goals. This participatory process may involve several integrative

facilitated meetings where the stakeholders first identify the priorities, and then to set goals informed by the maps and GIS data.

Models for implementation

Armed with data and maps, the next step is to set up a process for supporting the Greenprint maps and report. Implementation is a long-term process, and will be shaped by the coalition, resources and the types of sponsors involved. As with many planning processes, the value comes through implementation.

With a local government agency as a primary catalyst, the implementation process may be through an on-going planning process such as a comprehensive plan, or watershed plan. With land conservation organizations or land trusts as lead organizers, primary implementation strategies may include conservation financing and acquisition of land and easements. While priorities and goals may be similar, the framework for implementation may vary.

Communication, social network maps and analysis

Communication is critical for maintaining the partnership and supporting implementation. The role of the lead organization(s) is a crucial one in connecting the partners and keeping the plan moving forward.

Understanding how communication occurs between partners is also an important step in the process. Several participatory planning methods including social network mapping

have been used to look at the flow of community assets and understand how informal communication happens (Mandarano, 2008; Prell et. al, 2009).

Stakeholders in Central Texas

Diminishing green space in Central Texas has been a concern of stakeholder for several years. A formal process for consider this issue within a regional planning framework was initiated in the early 2000's by the Austin-San Antonio Corridor Council's Land and Greenspace Committee (http://www.thecorridor.org/). Initial green space inventories were conducted by member organizations of this group. The Travis County Greenprint and the following Central Texas Greenprint processes were established to conduct a detailed analysis and initiate a planning process for four of the five counties of the Envision Central Texas region. The primary conveners of the Central Texas Greenprint were Envision Central Texas (ECT), Capital Area Council of Governments (CAPCOG), and Trust for Public Lands (TPL); with University of Texas School of Architecture faculty members Barbara Parmenter and Sinclair Black providing GIS-mapping leadership and assisting in guiding the process. Envision Central Texas was responsible for much of the administrative activity, outreach, communication, and meeting organization. Capital Area CAPCOG served to connect with local officials and communities; and provided planning support such as GIS Data and technical support. TPL coordinated the Greenprint process and the final report preparation. TPL also provided expertise on conservation finance, conservation transactions, and research.

Together the organizations brought a diverse group of individuals and stakeholders that represented a wide range of interests and in the land use, conservation and growth patterns of the four county region of Central Texas. Volunteers were recruited to participate on committees or to participate in regional meetings. Discussions and decisions were made by consensus, with Envision Central Texas acting to convene and moderate discussions (Miller, personal conversation).

The organizational and support activities took place in several committees (The Trust for Public Lands, 2009b). A Regional Greenprint Steering Committee provided overall direction and guidance. A Technical Advisory Committee guided GIS data access and analysis, and provided the scientific and technical research direction. Stakeholder Groups were organized for each of the counties that participated in the Greenprint, Caldwell, Hays and Bastrop. The county-based Stakeholder Groups were organized based upon the commitment and participation of the local governments (Figure 8).

Between May 2008 and June 2009, stakeholder groups were convened to discuss the Greenprint process, actively provide input and shape the outcome. Participatory meetings were held to identify priorities, set goals and develop strategies. Between meetings, the Steering Committee and Technical Advisory Committee were engaged to develop the process, gather data, provide technical assistance and prepare for the next phases. The final outcome of the process was the *Greenprint for Growth: A Regional Action Plan for Conservation and Economic Opportunity (Trust for Public Land, 2009b).*

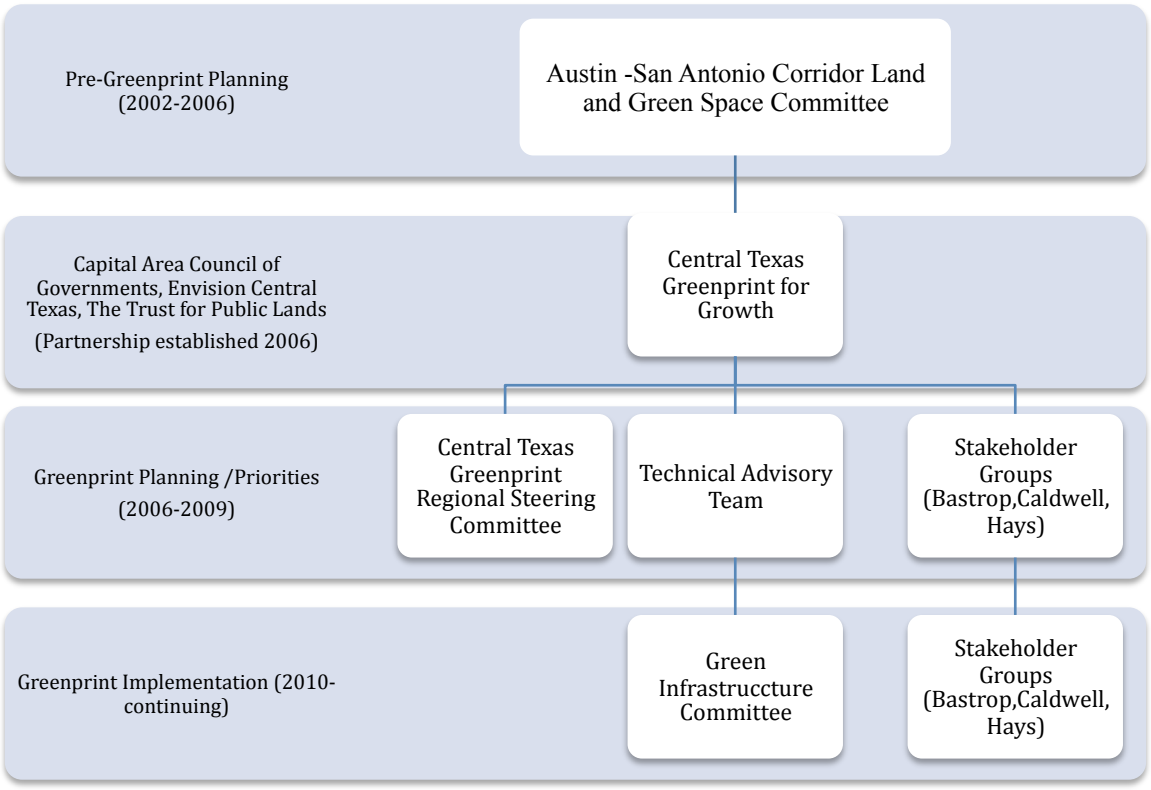


Figure 7. Relationships between the related Central Texas Greenprint stakeholder processes

Current activity is ongoing and support for the project is continuing, facilitated by Envision Central Texas. The emphasis has now shifted toward implementation with a newly emerging discussion occurring around support for strategies and local and partner support for conservation action. Beginning on October 27, 2010, a new round of Stakeholder Group meetings were initiated, the first in Bastrop County. At this meeting, more that 35 stakeholders joined to revisit the conservation goals, data and maps for the region. The group was informed about the current support mechanisms for the Greenprint process and the Green Infrastructure Committee, which has emerged to look at strategy implementation. A series of case studies, technical assistance tools, and a website for communicating information is in stages of development (author, personal observation).

Also during this meeting, a participatory planning exercise was undertaken to identify communication networks, and methods. The process will result in a better understanding of how data and information flow both formally and informally through this collaborative planning Greenprint process (author, personal observation).

Figure 8. Participants at a Greenprint stakeholder meeting

The integration of an ecosystem service approach into the collaborative Greenprint process will most likely require additional time and commitment by both the planners and the stakeholders. The process of assuring fair and equitable input and collaboration may require a more robust structure (Prell et. al, 2009) alternative process to the standard stakeholder meetings to understand the complex social interactions as well as the added complexity of a valuation or ecosystem prioritization process (Ernston et.al, 2008; Bodin et. al, 2006).

Strategies

One of the outcomes of the initial Central Texas Greenprint process and report was the identification of conservation strategies that would support the vision. The strategies that were identified include:

> •*Identify infrastructure corridors that support growth and maintain our natural resources*

•Integrate with local government comprehensive, economic, and park planning processes

•Avoid and/or mitigate conflict between growth and conservation

•Encourage sustainable growth that preserves our region's unique identity

•Provide scalable information in order to analyze the priorities at the level of a parcel of land, community, or the entire region

The current phase of stakeholder meetings and the work of the Green Infrastructure Committee are supporting the further communication, development, and implementation of these strategies. Integrating an ecosystem service approach is one potential additional strategy for supporting and implementing the conservation vision.

Outcomes and next steps

With the Greenprint Regional Action Plan completed, the Greenprint partnership is in the process of identifying ongoing activities for promotion. Ongoing efforts include:

- *Promote use of tool (report / maps) and online interactive mapping*
- *Educate stakeholders (public and private sector)*
- *Work with planners from jurisdictions and agencies to integrate into planning*

The discussion of integrating ecosystem service valuation has been included in recent stakeholder meetings, and a pilot social network analysis was introduced. While ecosystem services have been considered in the Greenprint process, there have been no formal activities to integrate. Additionally, one strategy has been to understand the processes for successful land conservation activities in the region and develop case

studies that can be used to promote best practices. Another strategy has been to work within regional policy initiatives and identify ways to connect the Greenprint Plan through local government planning initiatives.

Additionally, Green Infrastructure Committee has worked with partners to integrate conservation priorities into several regional planning initiatives including:

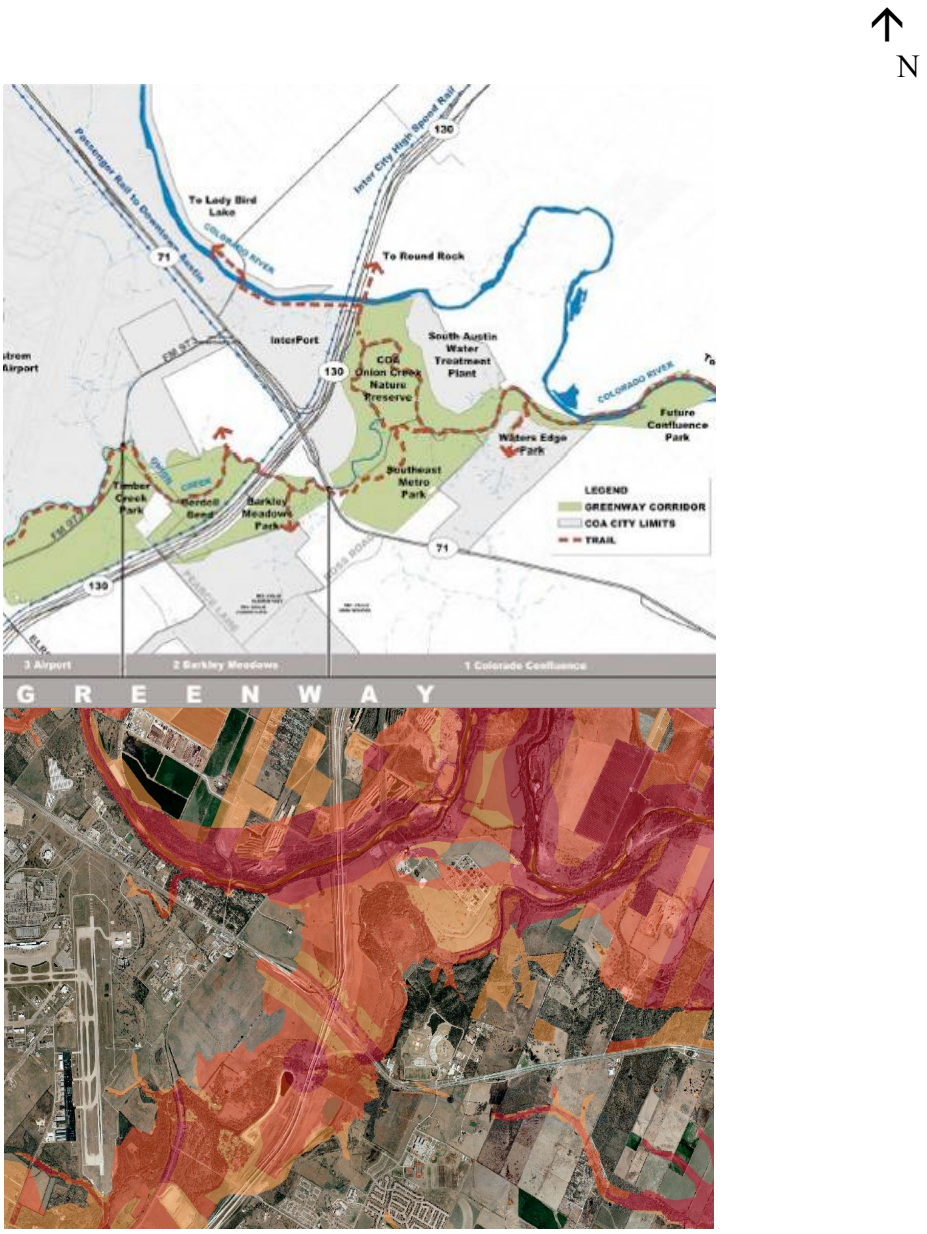
- Bastrop County Transportation Plan
- Caldwell County Transportation Plan
- Capital Area Metropolitan Planning Organization (CAMPO) 2035 Transportation Plan
- Hays County parks and open space bond decision-making process
- Travis County conservation rankings and greenway land acquisition prioritization

Case study: Onion Creek Greenway – concept plan

The Green Infrastructure Committee has identified a few high-priority case studies, to provide research, support, and implementation assistance. The Onion Creek Greenway is one example.

A new development that will shape growth in the region is the construction of SH 130. The intersection of SH130 and SH71 is located in an area that is of high conservation priority as identified by the Greenprint process as it is in a visible watershed that has potential value for recreation, habitat, and agriculture.

The Green Infrastructure Committee worked with planners from the County and CAPCOG to identify ways to enhance this new development to be consistent with the conservation goals. The concept plan that resulted creates opportunities for habitat preservation and recreation within the land adjacent to the development. The Onion Creek Greenway will run along 21 miles of SH 130, with a Spine of hike and bike trail running through parks – some with facilities, others natural. Funding for $8.6M from a 2005 parks bond is earmarked for the Onion Creek Greenway.



Proposed Onion Creek Greenway
Map: Greenway and trail route
Photo: Priority greenway land (dark=highest priority)

Figure 9. Onion Creek Greenway proposal for area identified as high priority for the Greenprint process.

Chapter Three: Greenprint for Growth case summaries

The Greenprint process has been implemented in more than 40 communities in the United States (http://www.tpl.org/tier2_pa.cfm?folder_id=3130). Implementation strategies and conservation priorities vary from region to region. While some Greenprints are being used to influence local and regional government strategic and comprehensive planning processes, others serve as a prioritization roadmap for land trust and non-profit organizations. With input from the TPL National Conservation Office, I identified two additional regional Greenprints that could provide implementation options as the Central Texas Greenprint moves forward. By studying the models, and interviewing key staff responsible for implementing the Greenprints, I learned more about implementation strategies and possible connections to ecosystem services. Cases were selected using the following criteria:

> 1) The program has been in place for at least 3 years (at least one year after the initial report). This selects for processes that have completed the planning process and have entered into the implementation phases.
>
> 2) It is collaboratively managed, and has a broad partnership to support on going activities.
>
> 3) At least one community goal is similar to Central Texas Greenprint, and can be associated to an ecosystem service.

Case 1: Upper Nuese River Greenprint, North Carolina

Information for this case review was obtained through a series of interviews in September and October, 2010 with Lisa Creaseman, Conservation Projects Manager for the Conservation Trust for North Carolina; and from the Conservation Trust for North Carolina's website (http://www.cntc.org).

Overview and geographic setting

The Upper Nuese River Basin is a 770 square mile watershed that contains the Upper Nuese River and nine water supply reservoirs. Six counties and eight municipalities are connected to or within the basin including the cities of Raleigh, NC and Durham, NC. The current population of 535,000 people is expected to double by 2030. While much of the region remains forested (60%), it is expected that development will convert more than 50,000 acres by 2025 and the portion of developed land is expected to increase from the current 20% to over 25%. Much of the development is projected to occur within the watershed (The Trust for Public Lands, 2006b).

History and background

The *Upper Nuese River Clean Water Initiative Conservation Plan* (The Trust for Public Lands, 2006b) was written to address the issues of rapid development and its impact on drinking water quality. Ideas for a clean water initiative were catalyzed by conversations between non-profit organizations such as the Upper Neuse River Keepers and Mayor Meeker, of Raleigh. The Mayor supported an initiative to promote conservation and water quality protection. The Greenprint process was employed to identify priority conservation lands for water quality and watershed protection. Unlike other Greenprint

programs that initiate a stakeholder process for identifying conservation priorities, the Upper Nuese River Plan began with water quality as the primary stated priority. With water quality established as the primary priority, the role of stakeholders was to identify the best methods and strategies for water conservation and water quality protection. Water quality has been a concern and priority for the region for several years. Durham City and Durham County passed bond initiatives in 1995 to protect greenways along creeks and tributaries within the basin. Similarly other counties within the region have set aside land to protect water quality (Creaseman, 2010a). In 2005, the Triangle J Council of Governments and Trust for Public Land initiated a community stakeholder process to identify strategies for water quality protection and other secondary priorities such as protecting working lands and preserving aquatic habitat. Through the Greenprint process, local and regional officials, agency representatives, and technical and scientific experts came together to develop a Water Quality Protection Scenario and an Overall Protection Scenario (including secondary priorities). The results were published in 2006 and identified about 24,000 acres of high priority conservation land that would be necessary to protect water quality (The Trust for Public Lands, 2006b).

Organizational structure, institutional capacity, and stakeholders

The Conservation Trust of North Carolina is the lead organization that is now carrying out the conservation strategies of the Upper Neuse Clean Water Initiative. The initial planning process was lead by the Triangle J Council of Governments and the Trust for Public Lands with primary funding from the City of Raleigh, North Carolina. The Plan is

a coalition effort. As a result, it is supported by municipalities, counties, agencies and land use organizations; and is incorporated into their planning initiatives as applicable. Stakeholders were involved in the mapping, weighting, and priority setting.

Community strategic goals

Through this process, water quality was identified as the driving and primary priority. The partnership understood that land use directly affected drinking water quality, and had a direct and measurable municipal cost. Calculated benefits for the Upper Nuese Watershed for water, wastewater and storm water services is valued at over $37 million annually or $28.31 per capita as revenue (Creaseman, 2010b) in overall benefits as a share of municipal water utility costs. Secondary goals that were identified in a second phase project included habitat conservation, heritage preservation, and protection of working lands (farms and forests).

Regulations, plans, and rules

Water quality plans and the need to maintain surface drinking water quality is a major driver for land use conservation and protection efforts. High nutrient loads in some reservoirs have lead to strong ordinances such as robust stream buffers and erosion controls (The Trust for Public Lands, 2006b). The North Carolina Neuse Nutrient Sensitive Water Rules set minimum protection standards, but some communities go beyond these minimum standards.

Resources, support, and funding

The City of Raleigh provided funding for the planning process, the Water Quality Initiative, and substantial support for land conservation efforts in the region. The Mayor of Raleigh originally was interested in supporting a land trust to acquire land and easements in the Upper Neuse watershed (Creaseman , 2010a). After discussions with stakeholders, funding and support were shifted to several local land trusts that were actively working in the region and strategically conserved land within the Upper Nuese River watershed. By conserving forested land within the watershed, water quality can be maintained (Postel and Thompson, 2005) at cost lower than that of water treatment. Six million dollars have been pledged to support the work and staffing of local land trusts. The Conservation Trust for North Carolina, estimated that every dollar spent directly with a land trust results in $17 worth of land protection through land acquisitions and easements, measured in matching funds, conservation finance, and donations (Creaseman, 2010b). The Conservation Trust of North Carolina coordinates the effort, and provides funding for conservation activities in six additional land conservation organizations.

Progress and outcomes

Efforts of partners in the Upper Neuse Clean Water Initiative have collectively (Creaseman, 2010a):

- Implemented 48 land use projects
- Protected 53 square miles of stream buffer

- Protected 5300 acres through direct acquisition and easements

Ecosystem services and future plans

Because of the concern to protect surface drinking water quality from nutrient contamination, efforts are being considered to connect land use conservation to water quality plans (Creaseman, 2010a). The region is characterized by agricultural production and increasing suburban development. Local water quality rules have been put in place to minimize the increasing nutrient contaminant levels from fertilizer, storm water, and other non-point pollution sources. Public utilities are assessed nutrient impact fees. Stakeholders are exploring the possibility of using land conservation as an alternative to impact fees. In this proposal, ecosystem services can be related to specific high priority lands, with a value related directly to the assessed impact fees.

Additionally, academic partners are in the initial stages of studying potential mechanisms for assessing the ecosystem benefits of working forests and sustainably managed lands for water quality (Creasman, 2010a). Water quality trading or other fee mechanisms may serve as a way to pay landowners for ecosystem services.

Case 2: Litchfield Hills Greenprint, Connecticut.

Information for this case review was obtained through a series of interviews in September and October, 2010 with Tim Abbot, Greenprint Director for the Housatonic Valley Association.

Overview and geographic setting

The Litchfield Hills region in Northwest Connecticut is a key part of the Housatonic River Valley watershed. The region is primarily rural, but near urban communities such as Hartford, CT and New York City. Growing development and increasing population stress the region. Loss of farmland, rural character and water quality are primary concerns (http://www.hvatoday.org/).

History and background

The Greenprinting process was initiated in 2006, with the data gathering and assessment completed in 2007 (Abbott, 2010). The Greenprint Plan was launched by Trust for Public Lands with support from private donors interested in maintaining the character of the rural area. In 2008 the management of the process shifted to the Housatonic River Valley Association a regional conservation and planning non-profit organization that serves the three states of the Housatonic River Watershed (Massachusetts, Connecticut and New York).

Organizational structure, institutional capacity, and stakeholders

The Litchfield Hills Greenprint process is managed and supported by the Housatonic Valley Association (HVA). The HVA is a not for profit land conservation and planning

organization that was created in 1941 and exists "to conserve the natural character and environmental health of our communities by protecting and restoring the lands and waters of the Housatonic Watershed for this and future generations (http://www.hvatoday.org)". After the initial Litchfield Hills Greenprint mapping and prioritization, the partners formed the Greenprint Collaborative to involve more local partners and provide continued support and assistance to the Litchfield Hills Region. The Greenprint Collaborative is made up of 24 out of 30 land trust organizations in the region. A primary benefit for member organizations is direct assistance toward receiving national land trust certification (Abbott, 2010). These land trusts and land conservation organizations make up the bulk of the decision-making partners that are involved in the Collaborative. Local government agencies provided Greenprinting mapping assistance and participate in working groups, but not as direct members of the Collaborative. In addition key town planners, elected officials and community leaders participate in the collaborative and on working groups. The six working groups address specific issues such as: private philanthropy and support, conservation development, and partnerships/shared resources. The primary focus of the Collaborative is to promote conservation investment and quality environmental development (Abbott, 2010).

Community strategic goals

The mission of the Collaborative is to protect the rural quality of the region and to maximize conservation. The state primary conservation priorities are:

- Preserve agricultural lands
- Protect drinking water quality
- Conserve forest systems

The Greenprint Collaborative has set a goal to conserve 50% of the regions available open space through purchase and easements, by 2025. The goal is to place 70,000 acres in a protection status to address the priorities of water, farms and forest (Abbott, 2010).

Regulations, plans, and rules

The large number of small town and municipal districts in the Litchfield Hills region, provides a planning and conservation challenge. Conservation at the town and municipal level are minimal because of limited funding and overlapping jurisdictions. Connecticut does have a county planning requirement. Each county must have a "Plan of Conservation and Development" that is submitted to the State and revised every 10 years. The plans address issues such as: alternative energy, housing, preservation of agricultural lands, and water quality and quantity. The local plans vary in depth and detail, and standards for the required planning process are minimal. However, this process may allow for localities to introduce ecosystem service analysis as a component of the planning process (Abbott, 2010). As resources allow, the HVA and the Greenprint Collaborative participate in county planning activities, and consider conservation planning for a fee on a case-by-case basis.

Resources, support, and funding

The Litchfield Hills Region is primarily rural with numerous second homes. Bond initiatives are rare. However, private philanthropy supplies funding and support for land conservation efforts. The primary source of funding is private foundations and individuals, with little coming from local government sources (http://www.hvatoday.org/).

An untapped, but potential source of funding is the Connecticut Water Utility fund. In 2003 the State of Connecticut set aside $80 million for conserving land for water quality (Abbott, 2010). The fund supports land conservation through municipal Water Utilities (The Highlands Coalition, 2007). The Greenprint Collaborative is considering ways to leverage efforts with nearby water utilities.

Progress and outcomes

The Greenprint Collaborative has set a goal for conservation through easement and purchase. Because of the large number of small towns, municipalities and districts, measuring the amount of land that was currently protected was difficult. Records were inconsistent and in some cases non-existent (Abbott, 2010). The Collaborative initiated the task of consolidating records and investigating easement language. The painstaking process of creating a database of land trusts, easements, and conservation areas was

difficult but became the most complete record in the State. With this information as a baseline, measuring the conservation goals could now be completed.

Based on the Greenprint Collaborative measurements, the following Litchfield Hills Region land is protection (Abbott, 2010):

- 32% of the regions forests
- 18% of the region's agricultural lands
- 21% of the region's water quality protection lands

Ecosystem services and future plans

Ecosystem services are an underlying reason for aggressive conservation goals and efforts. Farmland preservation is seen as is important to maintaining the rural quality of life, and protecting the regions forested lands are connected to maintaining water quality (Postel and Thompson, 2005). While seen to be important, there has not been an attempt to monetize the value to the priority conservation lands (Abbott personal conversation, 2010). However, the conservation priorities can be defined in terms of ecosystem services. Forest protection is a priority in the Litchfield Hills and surrounding regions. Some of the ecosystem services important to the region provided by forests protect water quality (Postel and Thompson, 2005; The Highlands Coalition 2007) and improve air quality through filtration of pollutants (The Highlands Coalition, 2007). Regional efforts are looking at the impact of local forests on climate regulation and green house gas

reduction (The Highlands Coalition, 2007). Future Greenprint Collaborative efforts may include ecosystem service conservation funding projects such as wetland mitigation, and rare and protected species banking.

Advantages and challenges of Greenprinting and ecosystem services in a region

While these two cases in no way present a complete picture, a few lessons start to emerge. In both cases, there seems to be a key regional priority that drives the process. Water quality in the Upper Nuese, and farm and forest preservation in the Litchfield Hills. An ecosystem service approach seems to be a secondary part of this process, and considered a method for attaching a value for the priority goal. In the case of the Upper Nuese watershed, a focus on the ecosystem service value of the watershed appears to be a way to gain resources and funding opportunities.

However, neither process has yet attempted to identify and quantify all of the ecosystem services that are connected to their particular watershed or landscape. This process would most likely require more resources, time, and expertise than can currently be devoted. Partnerships with academic institutions may be one way to produce a more complete ecosystem assessment and begin to identify or collect the data necessary to better understand the regional ecosystem service value.

Chapter Four: Ecosystem services

In 1997 a team of economists (Costanza et. al, 1997) calculated the value of the services that the Earth's ecosystems provide to human populations as $33 trillion average per year (US), or nearly double the world's gross domestic product (GDP) of $18 trillion (US). A large portion of ecosystem services were not accounted for by economists or included in our economies. However, replacing the services that are provided by these ecosystem functions would be costly to communities. For some ecosystem services (such as aesthetics), it may be difficult or impossible to estimate value for the benefits provided yet they contribute directly to quality of life and define a region's unique sense of place. While this study (Costanza et. al., 1997) was not the first to define ecosystem services it was the most comprehensive, and communicated the concept to planners, policy makers, multi-disciplinary experts, and the general public in a way that expressed urgency. A shift occurred in the way we considered ecosystems. Planners and policy makers now saw the value and connections between such actions as protecting our wetlands for providing clean water for cities, or conserving native grasslands as a benefit to pollinating our domestic crops. Triggered by this study and numerous studies that followed, a collaboration of more than 1300 experts undertook an extensive effort to systematically define ecosystem services and more accurately determine their condition. The effort was the Millennium Ecosystem Assessment (MEA), and after several years of research and debate the MEA reported that an estimated 60% of the Earth's ecosystem services were at risk and being degraded (Millennium Ecosystem Assessment, 2005).

Ecosystem service studies and projects are not without critics. Assessing value is difficult, especially when considering an ecosystem's multiple benefits. For a given ecosystem, its value is a sum of all of its benefits. Problems arise when assigning partial value or calculating multiple values for a region. Translating values across geographic scales is also a challenge. Ultimately, the methods for valuing benefits are limited by available data (Norgaard, 2008; Daily and Matson, 2008; Lant, Ruhl and Kraft, 2008).

While there are many limitations to these studies, one of the most challenging has been downscaling, or applying this knowledge at a local or regional scale. For instance in the example of the Central Texas Greenprint, it will be difficult to identify a natural resource value for a particular property or community when our data is aggregated at a state or even global scale, or the actual value is received by communities and individuals outside of the region. Many of the ecosystem services, such as fisheries production and clean water, transcend political and jurisdictional boundaries. Assessing costs and benefits, and assigning directly to a governmental entity or jurisdiction is difficult. Some natural resource values, such as fisheries and water quality, may be "seen" at a larger scale but not at a local jurisdiction or management level scale. For instance, how does the upstream locality that is responsible for protecting the resource, receive compensation for the health of the downstream fish population that is a result of good management practices? Moreover, our systems of environmental and economic governance are not designed to account for ecosystem services on a systematic basis at any level. Yet it is

difficult to protect and maintain our ecosystems without a more complete understanding of the value of the benefits they provide.

Fortunately, we can implement an ecosystem service approach even though we do not have a monetized economic value. While rules and regulations are not in place to assess ecosystem services, there are numerous innovations and case studies of local and regional applications of ecosystem service approaches (Goldman et. al, 2007; Postel and Thompson, 2005; Tallis et. al, 2009). Cities such as New York (http://blogs.ei.columbia.edu/2009/09/03/ecosystem-services-come-to-new-york-city-the-natural-way-to-reduce-pollution/) and Austin (http://www.ci.austin.tx.us/water/wildland/waterqualityprotectionland.htm) have protected open space, aquifers and forests as a component in their water utilities strategy to provide clean drinking water. Wetlands are being conserved and restored as a buffer to protect coastal communities against storm surges and coastal erosion. Sustainable agricultural practices are put into place and native grasslands are being protected to maintain pollinator habitat for crop production. In each of these examples, policy decisions were made because of the economic benefits. In some cases local coalitions and organizations have used ecosystem services as a tool for connecting with funding sources for conservation and land use planning efforts.

One strategy for applying an ecosystem service approach is to capture and calculate direct actual values using such methods as “willingness to pay”, contingent value, or

direct benefits (i.e. "what is the annual value of a fisheries catch?") (Boyd and Banzhaf, 2006; DeGroot et. al, 2002). Another strategy is to educate, communicate and identify community priorities. One challenge will be to identify mechanisms to connect landscape scale ecosystem services with local and regional governance.

As a collaborative, community-based land conservation effort, the Central Texas Greenprint Plan may serve as a model for implementing a regional ecosystem service approach. Community priorities were identified through an involved stakeholder process, and localities and agencies continue to have a guiding role. The Greenprint Plan provides the elements for integrating an ecosystem service approach at local and regional scales. The inclusion of ecosystem services into this planning process may provide additional opportunities to provide data for conservation policy and opportunities to consider additional resources and conservation funding. It may be difficult to produce economic valuations and monetize ecosystem services through a collaborative process, however stakeholders can provide valuable input and identify and prioritize locally important ecosystem services. Additionally a collaborative process can provide input for identifying sources and data for calculating values. While there are many challenges for the application of ecosystem services, effective deliberative democracy and the increasing willingness of natural scientists to consider social and economic issues and the connection to ecological systems, and to work across scales are necessary and positive benefits of ecosystem service planning (Norgaard, 2008).

Defining ecosystem services

Boyd and Banzhaf (2007, p.8) offer a useful definition for ecosystem services as "the functions of ecosystems that have a direct benefit to human populations." One way of looking at ecosystem services is as the ecological or green infrastructure that provides functional support services for our communities. The loss of ecosystem services results in compromises to our support services and results in direct economic costs. The Millennium Ecosystem Assessment (MEA, 2005) categorized ecosystem services as:

- ***Provisioning services:*** The products obtained from ecosystems, including genetic resources, food and fiber, and fresh water. Examples include commercial fisheries and farmland production.
- ***Regulating services:*** The benefits obtained from the regulation of ecosystem processes, including the regulation of climate, water, and some human diseases. Examples include flood protection and pollutant removal.
- ***Supporting services:*** Functions necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat
- ***Cultural services****:* The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience as well as knowledge systems, social relations, and aesthetic values.

In Central Texas, ecosystem services that are likely to resonate with stakeholders and be identified as priorities would especially include: provisioning and regulating services that work together to provide clean and available water, and help to control flooding; and cultural services to support the region's recreation, agricultural landscapes, and tourism.

An ecosystem service approach connects the people who receive benefits, to the landscape that provides the services. This perspective is one that allows us to take a pragmatic approach to integrating watersheds, ecosystems and landscapes into our community planning. An ecosystem services approach is one that prioritizes and quantifies ecosystem functions based on human needs. The outcome of such studies may be a certain economic value, or a qualitative identification of ecosystem services as meeting a critical human need. This approach may be an appropriate framework for addressing the elements of ecological, biophysical, and social considerations that are inherent in landscape-scale planning processes such as habitat conservation, watersheds, and bioregions- a scale at which biodiversity is effectively measured and understood.

Interest in ecosystem service valuation has been increasing as environmental managers and policy makers increasingly see the connection between ecosystem health and our ability to maintain nature-based human support systems (Feldman and Blaustein, 2006; Ruhl et al. 2008). As more attention is given to major ecological and natural resource changes and shifts such as fisheries depletion, climate change, and water shortages, so too is the dialog about ecosystem service valuation.

Studies that have taken a comprehensive look at the world's ecosystems (Costanza et al 1997, 2002; Daily, 1997) have shown that we have greatly underestimated the economic benefits of our ecosystems to society. Failing to protect the ecosystems will result in economic loss and distress to our human populations and biodiversity. At a regional scale, the City of San Antonio and American Forests applied techniques to measure ecosystem services and the value of urban forests. With 38% overall tree canopy, the value of trees in San Antonio were calculated to provide: $30 million in air quality benefits by removing nitrogen dioxide, sulfur dioxide, carbon monoxide and particulate matter (American Forests, 2009). A recommended increase to 40% overall canopy cover would result in an additional removal of 721,000 pounds of air pollutants valued at $1.7 million (American Forests, 2007). The City of Austin Wildlands is another local example of ecosystem service management and is an effort to preserve open space to protect water quality within the Barton Springs watershed (http://www.ci.austin.tx.us/water/wildland/).

An additional outcome of an ecological service benefit framework is in identifying and prioritizing the benefits for planning and management purposes. While we may not have all of the data to accurately estimate the value of a river or wetland to the commercial fishing industry, we can communicate that without appropriate freshwater in-flow and wetland protection our fishing nurseries will deteriorate rapidly. Understanding

and communicating the importance of the system is a first step, while an assessed value will provide additional supporting data.

Ecosystem services do not operate within a political planning area but across those jurisdictional boundaries. Since they flow along natural, rather than planning or jurisdictional boundaries, a regional approach is necessary. Also as Feldman and Blaustein (2007) suggest, we need to develop an alternative to our single-media (air, water, and waste) approach for successful ecological planning, and an ecosystem services may be an effective option. It is because of these unknowns-scientific, political, and social- that an ecosystem services approach may be appropriate for dealing with the messiness of social-ecological systems and common pool resources.

As the discipline of ecosystem services is gaining momentum, the call for a reasonable policy response is becoming stronger as evidenced by the EPA's Ecosystem Benefits Policy (2007) and other regulatory and agency attempts to define and apply these concepts. Difficulties remain as much of the work in this area remains divided among those studies by economists and studies by ecologists. However interdisciplinary research is receiving greater attention. Entering into this debate is the need for a policy and law response. Several legal scholars (Ruhl et al., 2007; Salzman, Feldman and Blaustein, 2007) are addressing the needs for our political system to adapt to this concept.

However as Feldman and Blaustein (2007) points out:

> *The disconnect between law and ecosystem services is especially conspicuous because safeguarding ecosystem services is increasingly understood as an objective for environmental policy and regulation and fundamental to the management of natural resources. Moreover, there is a growing appreciation that the traditional single media focus (air, water, and waste) of environmental law and policy cannot secure provision of the resources, health, and communal needs that are central to human communities. Constructing law and policy informed by a cross-media understanding of ecosystem services would surmount that limitation of current environmental regulatory regime.*

From a global perspective, the MEA reports that more than 60% of our ecosystem services are negatively impacted (Reid, 2007; Tallis and Karieva, 2007). The MEA report as a compilation of models and information from more than 1360 scientists/authors, 850 reviewers and 20, 742 comments; is perhaps of the most comprehensive looks at global health to date (MEA, 2005; Tallis and Karieva, 2007). The level of contribution and review to this report is without compare. However issues with data gaps, scale and fineness of data prevent this from being a tool that can be directly applied at the regional or local level. MEA relied on linking many loosely connected models. As a result, some predictions have limited applicability at scales much below the global level. For instance, annual water discharge amounts are considered reliable at the river basin scale, but not at the watershed or sub-watershed level (Tallis and Karieva, 2007). Also, the data used is for long-term averages, which has little applicability at a management scale. Issues such as local impacts of climate change and rapid land use change would not be reflected at the regional scale. Some of the data and model issues that are considered weaknesses include: " …i) the absence of key

feedbacks between model components, ii) the inability to predict thresholds, iii) poorly documented connections between ecosystem services and human well-being." (Tallis and Karieva, 2007)

One outcome of an ecological services approach is to quantify the economic benefits of a regional ecosystem such as a stream, watershed or bay system. However, for many planning initiatives, the function of identifying and prioritizing the benefits is a critical and necessary first step. It is not necessary or possible in all instances to develop an economic model. As a method, ecosystem services will allow for economic quantification when the model and data allow, and for identification and prioritization in all instances. Daily et. al (2009) argue that the valuation process is imperfect and should not be a means to an end. An ecosystem service approach needs to be integrated into institutional decision making processes to provide a framework for land use and conservation decision. While economic and biophysical models are continually, institutional and decision making processes should advance simultaneously.

Valuation techniques, such at willingness- to- pay (WTP), travel cost (TC) estimates and direct economic measurement are not applied without difficulties (Boyd and Banzhaf, 2007). While the information derived from these models is certainly beneficial, an ecosystem service framework should not be based only on these tools. Some of the challenges that can arise include:

1) Economic data (such as fisheries values, and tourism income) while a good indicator of ecosystem service value are not always available at the level and detail necessary to apply at a smaller local or regional scale.
2) WTP and TC estimates have often resulted in overestimation of value. Once in a vacation spot, travelers are often optimistic about future economic conditions.
3) Actual ecosystem service valuation is highly case specific. Methods used to place a value on such things as pollination services, coastal protection, and water cleansing are inconsistent. At other times the data for estimating such things has not been collected (Houston Advanced Research Center, 2008).

Focus on watersheds: One of our most "valuable" ecosystems

Globally, watersheds provide the most ecological services that have the highest calculated economic value (Costanza et al, 1997). Watersheds provide invaluable benefits to society. Many of which are replaceable only at a high cost. A study of twenty-seven water supply systems in the U.S. calculated the value of forested and protected watersheds and showed reduced cost for the cities that maintained forest cover. Those cities or regions with at least 60% of the watershed in forest cover experienced a 50% reduction in water supply costs over regions with only 30% cover (Postel and Thompson, 2005; Table 1).

Table 1. Forest cover and predicted water treatment costs based on 27 U.S. water supply systems (Postel and Thompson, 2007).

Amount of watershed covered by forest	Cost to treat 3,785m^3 water	Average annual treatment cost	Cost increase of 60% forest cover
60%	$37	$297,110	0
50%	$46	$369,380	24%
40%	$58	$465,740	57%
30%	$73	$586,190	97%
20%	$93	$746,790	151%
10%	$115	$923,450	211%

Postel and Thompson (2005) emphasize that the benefits supplied by watersheds are some of the most valuable to society and ecosystems. The benefits supplied by watersheds fit broadly into the following categories: water filtration/purification, seasonal flow regulation, erosion and sediment control, and habitat preservation. For many regions including Central Texas, recreation and tourism are an important service provided by ecosystems and can be assessed in terms of direct economic impact at local spending (Trust for Public Land, 2009).

Brauman et al. (2007) offers another broad classification of ecosystem services related to hydrologic processes. Here the hydrologic ecosystem services are organized as: improvement of extractive water supply, improvement of in-stream water supply, water damage mitigation, provision of water related cultural services and water-associated supporting services. Presented in Table 2 is a watershed specific list of ecosystem services identified by Postel and Thompson (2005).

Table 2. List of watershed ecosystem service benefits (Postel and Thompson, 2005).

• Water supply for agriculture, industrial, and urban-domestic uses.
• Water filtration/purification
• Flow regulation
• Flood control
• Erosion and sediment control
• Fisheries
• Timber and other forest products
• Recreation/tourism
• Aesthetic enjoyment
• Habitat for biodiversity preservation
• Aesthetic enjoyment
• Climate stabilization
• Cultural, religious, inspiration values

Brauman, et al. (2007) explore the relationships between the biophysical processes and the ecosystem benefit provided, by connecting ecosystems service benefits to watersheds and functions. Table 3 presents a preliminary assessment of the ecosystem service benefits provided by watersheds to the method for evaluating the value, the ecological indicators, and the measurable watershed indicators; and provides a structure for connecting an ecosystem service benefits to other common environmental planning processes such as habitat plans and watershed plans. The valuation methods indicated are common techniques for assessing value. Contingent valuation assesses the stated preference cost or willingness-to-pay that individuals reveal through surveys. Hedonic pricing assesses preferences based on property values. Travel costs are assessed by expenditures of individuals when enjoying the ecosystems services of parks (for instance). Avoided costs are the costs of services provided by ecosystems that would need to be provided though another engineered or management solution, such as water purification.

Table 3. Ecosystem services, valuation method and connected ecological, water quality and physical watershed measures (author).

Ecosystem Service	Ecosystem Service Valuation Method	Ecological and Water Quality Indicators	Physical Watershed Indicators
Water filtration and purification	Contingent Valuation Avoided Cost	▪Metals ▪Sediment ▪BOD ▪COD ▪Toxics ▪Wetland extent/loss ▪Biodiversity ▪Impaired Stream segments	▪Turbidity ▪Flow ▪Impervious Cover
Flood control	Contingent Valuation Hedonic Pricing Avoided Cost	▪Land Cover ▪Wetland extent/loss ▪Biodiversity ▪Non-native species	▪Bank erosion ▪ Channel width-depth ratio (for 100 year flood plain assessment
Erosion and sediment control	Contingent Valuation Hedonic Pricing Avoided Cost	▪Land Cover ▪Wetland extent/loss ▪Biodiversity ▪Non-native species	▪Bank erosion ▪ Channel width-depth ratio (for 100 year flood plain assessment
Recreation/tourism	Contingent Valuation Travel Cost	▪Biodiversity ▪Sediment ▪BOD ▪COD ▪Metals ▪Toxics ▪Land Cover ▪Wetland extent/loss ▪Biodiversity ▪Non-native species ▪Impaired Stream segments	▪Turbidity ▪Flow ▪Bank erosion ▪Impervious cover (greenway development)

Integrating ecosystem services and Greenprinting

Ecosystem services and Greenprinting together, provide a framework for planning for land conservation. Combined, the two methods provide an opportunity to recognize the properties that meet the desired land conservation priorities; and identify, and in some cases estimate, the economic value of the conservation lands. Greenprints map areas that stakeholders consider desirable, and an ecosystem service approach articulates the business case for why these lands are valuable to a community and what direct human benefits are protected through conservation efforts.

Common to both processes is an active participatory process that requires the involvement of subject matter experts such as ecologists, GIS experts, economists and others. In Central Texas, Envision Central Texas enrolled experts from various disciplines in the process. Creating incentives for experts to continue their involvement is an important part of the sustainability of such collaborative processes. In most cases, Greeprinting is a community-based, collaborative process led by experts and organizations such as Trust for Public Lands. While local governments are often involved in the process to various degrees, the stakeholders include a variety of organizations and the process is guided by the consensus conservation priorities rather than regulatory guidelines. The Central Texas Greenprint process is no exception. Stakeholders represent a variety of sectors and interests and the Greenprint process presents scenarios to achieve the desired conservation priorities. The stakeholder process can likewise support the identification of ecosystem services and ways to assess values.

Both the Greenprint process and an ecosystem service approach highlight important aspects of ecosystems and together identify areas of multiple benefits. A planning approach that takes into consideration where values and services coincide and are optimized can implement a high performing green infrastructure approach and maximize benefits to the public. The processes offer different ways to look at land conservation prioritization. The Greenprint is a graphical representation of the biophysical properties of the ecosystem, while ecosystem services provide an assessment of the ecological processes. By combining both methods of assessment, we are able to communicate a more complete assessment of the value. A challenge with applying an ecosystem service approach, is translating value across scales and between ecosystems or landscapes. Combined with a Greenprint process, it may be possible to assess ecosystem services more directly and capture the values of multiple benefits. By identifying data sources for assessing ecosystem services, we may be able to incorporate social, economic, and use data with the ecological mapping. As an example, stakeholders in Bastrop County, Texas have identified farmland preservation, parks/recreation and water quality among the top Greenprint priorities. The Greenprint process maps the lands that meet these priorities. Ecosystem service methods could be applied to assess the value of ecosystem services for recreation, food production, water filtration, air quality purification, and agricultural tourism. Landowners and decision makers can use this assessment to more fairly evaluate choices between conservation and development, and the value of open space on the meeting local community priorities.

An enhanced Central Texas Greenprint that identifies ecosystem services values and priorities would be beneficial to local government strategic and comprehensive planning efforts. The enhanced Greenprint maps could provide information for municipal strategic assessments and cost – benefit analysis, and become integrated within the budgeting process. These combined tools would be a way to assess "green infrastructure" as we assess other municipal infrastructure project. Efforts are being made to influence planning decisions in local efforts such as toll road planning, and water planning. There are challenges to integrating an ecosystem service watershed approach in Central Texas. Much of the Central Texas water resources are subsurface in Karst aquifers. The ecosystem service value is often seen in communities far away from the recharge zones that need to be protected. Incentives and mechanisms such as cross-jurisdictional water trading programs are difficult to implement and manage. Additional outreach efforts to include local governments and state agencies can identify specific opportunities in the early stages of decision-making. An assessment of local government decision-making tools can help to assess data needs. As Daily et. al (2009) suggest, the ability to develop an institutional decision-making framework is a crucial parallel step to actual economic and biophysical assessments. In chapter 5, we will explore how social network assessments can be used to increase outreach and communication among stakeholders, and provide for more complete input into the decision making process.

Chapter Five: Collaborative communication and social network analysis

Social network analysis is a useful method for analyzing how knowledge, information and resources are transferred between individuals and organizations, principally in a voluntary or collaborative management process (Mischen and Jackson, 2008; Provan et. al, 2005; Scott, 2006). As a method, social network analysis can be utilized to map interactions and sharing of knowledge between experts, organizations, advocates, and various stakeholders within a community based environmental program, such as the Central Texas Greenprint process. Outcomes may include improved insight into the methods of communication; and transference of data, complex concepts, and local knowledge between stakeholders. Specifically, social network analysis considers the number, strength and quality of communications between stakeholders within a community-based program. The method attempts to answer the questions "Who talks to whom?" and "Who listens to whom?"

Social network mapping can be shared with stakeholders and used with other participatory planning tools to understand how community based environmental programs or collaboratively management programs can be effectively implemented. A social network map can be used to:

1) Understand the way that communication networks form and how information is transmitted between stakeholders.
2) Highlight communication gaps and missing stakeholders and proactively create new communication opportunities and connections.

3) Build upon this knowledge and provide a framework and roadmap for future communication.

Background

Social network maps can be used to describe the patterns of communication within a community and the links between relationships. Collectively, social network maps combined with other community data collection methods such as asset maps, cognitive maps, and concept maps can illustrate important aspects of a community and social resources that can be used to complement the Greenprint's natural resource analysis (U.S. Environmental Protection Agency, 2002)

Combining the social mapping tools with the Greenprint process could be a powerful way of illustrating the natural and social capital of a community. It is also a way to integrate social and natural resource information to provide a more holistic and complete illustration of an ecosystem, landscape or watershed. Community-based environmental projects and collaboratively managed projects assimilate both social data and natural resources data into the decision making process. Social network analysis and mapping is explored as a method of complementing the Greenprint natural resource analysis and illustrating the community's social capital.

Social researchers have used the methods of social network analysis to study the links between people, methods of communication, and attitudes. While modern social network analysis methodology was developed in the 1960s, the method is connected to several schools of social research that sought to systematically understand social patterns. Social network analysis borrows from social psychology; social perception and group structure; and the geometric portrayal of groups and relationship –or sociometery (Scott, 2006).

Social network theory also has connections to organizational development, knowledge management, and complexity theory. Mischen and Jackson (2008) contend that social network analysis may be an effective way to analyze the informal knowledge networks that develop between "street level bureaucrats" (Lipsky, 1980; Hill, 2003). Lipsky (1980) made the point that the informal communication and networks that are developed within local governments and agencies may be more important than the formal systems that are put in place by the bureaucracies. Furthermore, those that implement the policies and programs at the "street-level" often have a hand in shaping policies and programs- and should be involved in their development from the start. To some extent, this understanding can translate to collaboratively or adaptively managed programs such as the Greenprint programs. Individuals from both public and non-profit organizations are charged with implementing a program that has direct benefit to the community. It is important to creating a common understanding of how this will be managed and how local policies- both formal and informal- will be made and implemented. The communication network becomes a critical link in assuring success of implementation.

The networks that develop between individuals or bureaucrats exhibit a high degree of complexity and evolve over time by learning. Networks adapt to environment and changing conditions and new information. Knowledge networks are complex adaptive systems between individuals with varying degrees of connectedness (Mischen and Jackson, 2008; Scott, 2006). The degree to which networks adjust and in what direction, in large part is due to how strong the interaction is between the actors, or how connected they are.

Social network analysis: Environmental and ecology applications

There is an interest in the use of social network mapping and stakeholder analysis in environmental and ecological studies (Prell et. al, 2007). Collaborative management and participatory planning are becoming increasingly common for implementing regional scale, multi-dimensional environmental programs. Community based environmental projects are designed as networks of cooperative partners that are connected by a common issue(s) or by the desire to develop common outcomes. The environmental challenges that we face today such as drought management and water availability, habitat conservation, and fisheries management involve both private and public partners and transcend political, ecological and disciplinary boundaries. A top-down, single agency approach is insufficient for dealing with complex, community-wide issues. Successfully managed programs will optimize the social capital of stakeholders and create a collaborative management structure. While a convener or facilitator may take the lead in connecting the partners and developing a network structure, the final partnership is the

work and design of the stakeholders that choose to participate or are driven to participate by the potential outcome or perceived value. Collaborative management will change and evolve in time as more participants are involved and as understanding increases with increasing information. The Central Texas Greenprint and the other Greenprint programs fit this model of collaborative management.

Social network methods have are one way of more thoroughly understanding the collaborative planning process (Scott, 2006; U.S. Environmental Protection Agency, 2002). Social network matrices and maps can be used to increase knowledge of the social capital of a community and lead to strong implementation of community based environmental projects such as the Greenprints. Trust and cooperation between partners leads to increased social capital and leads to effective information sharing, reduced conflict and agreement to implement voluntary changes (Mandarano, 2009).

Researchers and practitioners have used social network analysis to look at such issues as: the effectiveness of collaborations between inter-agency partners in the management of a National Estuary Program (Mandarano, 2009), the co-management between multiple user groups in urban green spaces (Ernstson et. al., 2008), and the development of management plans for National Parks (Prell, et. al., 2009). Social network mapping tools are commonly used in the development of watershed plans and other community based environmental planning processes (U.S. Environmental Protection Agency, 2002).

As a method of understanding informal communication networks, social network maps can present an incomplete picture. Social network maps can provide a picture of how connections occur, but not why connections occur. Additionally, social networks are constantly changing and new information, stakeholders, and conditions (i.e. budget cuts, new program duties) are added to the process and the social network can change (Mischen and Jackson, 2008). Also, social networks analysis does not capture other components of networks such as capital resources, agency support, or regulatory drivers. To capture these additional components, techniques such as asset mapping, concept mapping or cognitive mapping may be useful (U.S. Environmental Protection Agency, 2002). While these additional community-mapping techniques will not be explored in this report, the techniques could be useful in Central Texas. For instance, method such as asset maps and concept maps could possibly provide a graphic representation of the distinct, but overlapping regulatory and planning processes such as habitat conservation plans and watershed plans, and illustrate the connections between the various agencies.

Practice and theory

Social Network Analysis can take different forms for the researcher and practitioner. For the researcher, advanced analytical techniques are used to quantitatively describe the interactions between actors, individuals or agencies. Their interactions are described by: reachability, access to many individuals; density, many links to others in the network; betweeness/modularity, the degree of separation within a groups, and centrality (Bodin et. al, 2006; Scott, 2006). Each of these conditions can be described numerically and

mapped accordingly to describe the number of interactions between group members, the number of connections between group members, and the frequency and strength of contacts.

High centrality minimizes the number of opportunities to learn from other projects or experiments, high reachability describes maximum flow of information and a high degree of communication; high density allows for redundancy and partners that provide similar interactions and information; higher betweeness will lead to possibilities of fragmentation or cliques within the group (Figure 10). By understanding these characteristics quantitatively, one can design for and implement communication practices that address the conditions or issues.

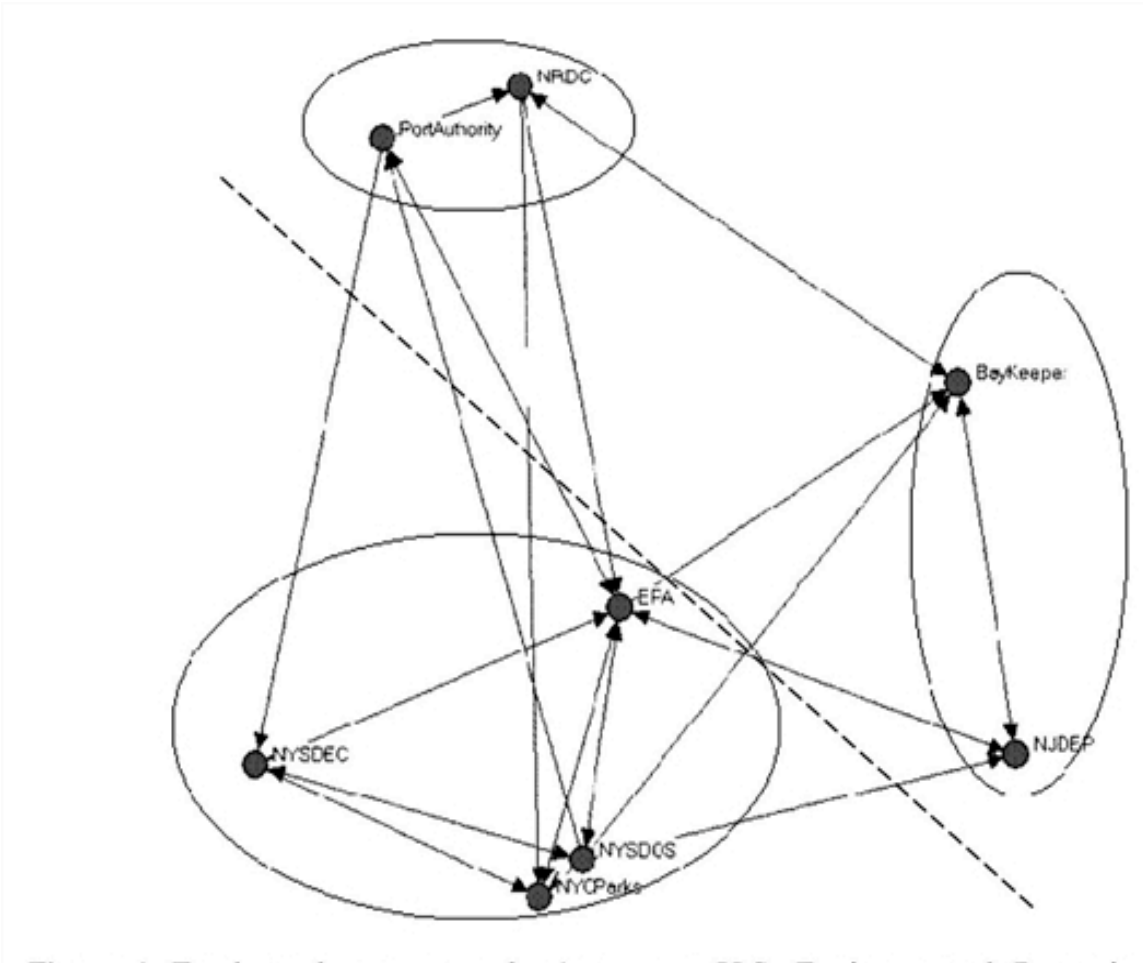
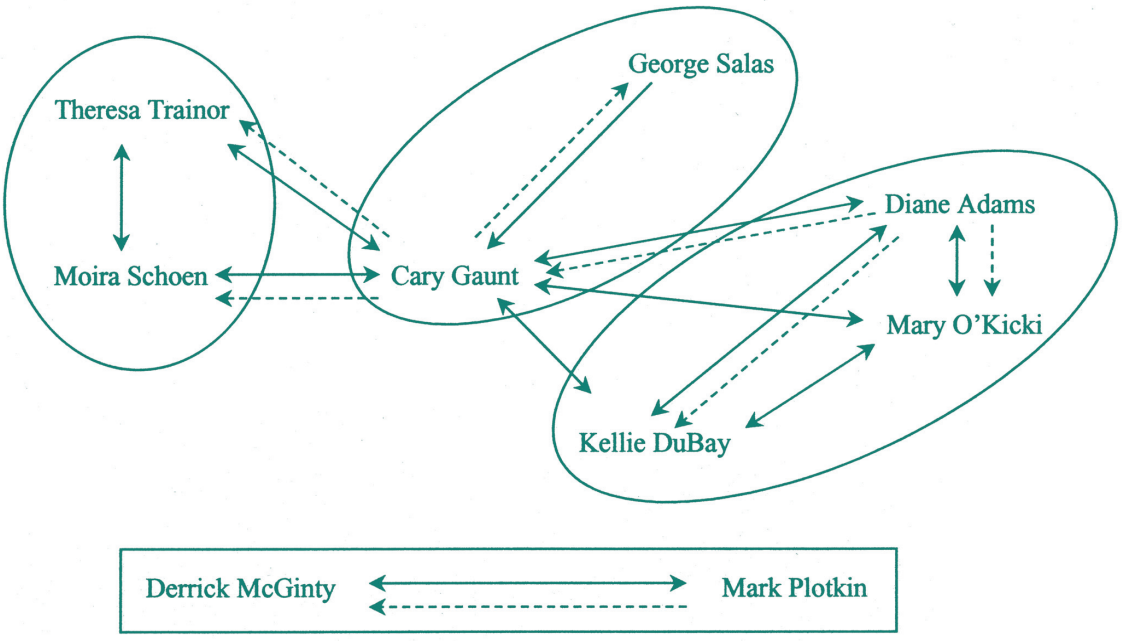


Figure 10. Example of a social network diagram designed using UCINET software by Mandarano (2009), showing connections and networks between agencies involved in the New York- New Jersey National Estuary program.

In practice, social network mapping can be applied in a more direct way to illustrate network connections and information flow. Information can be gathered though formal or informal participatory methods such as interviews, surveys, and focus This approach, while it does not provide the rigorous quantitative analysis desired for an in depth research, does provide valuable information for the practitioner or community planner. The EPA has illustrated social network techniques for practitioners in "Community, Culture and Environment: A Guide to Understanding Sense of Place" (EPA, 2002). The methods outlined, have been used to guide community based planning efforts such as watershed plans, smart-growth efforts, and estuary planning processes. Figure 10 illustrates the type of map that can be developed, and Figure 11 shows the type of matrix used to collect information.

Figure S4-37—Social Network Map
GROUP AFFILIATIONS



EXPLANATION: This map is identical to the previous example, except that the group affiliations of this network have been overlaid on the individual relationships. This additional information shows that Cary Gaunt from the Forest Service is a gatekeeper between the environmental group, Trout Unlimited, and local ranchers. Theresa Trainor and Moira Schoen receive advice about rangeland conservation from Cary. Cary receives her advice from Diane Adams, a local rancher. The female ranchers receive advice from Diane Adams. Derrick McGinty and Mark Plotkin do not discuss, or receive advice about, rangeland conservation from the rest of the local ranchers or the other groups. Other assessment methods could investigate the reasons for their isolation.

Figure 11. An example of a social network map from Community, Culture and the Environment: A Guide to Understanding a Sense of Place. (EPA, 2002)

Figure S4-38—Social Network Matrix

QUESTION: Who do you ask for advice about rangeland conservation?

	TT	MP	DM	CG	GS	DA	MO	KD	MS	WH			
1. Theresa Trainor	X			1									
2. Mark Plotkin		X											
3. Derrick McGinty			X										
4. Cary Gaunt				X									
5. George Salas					X								
6. Diane Adams						X							
7. Mary O'Kicki							X						
8. Kellie DuBay			0					X					
9. Moria Schoen									X				
10. Wilson Horn										X			
11.											X		
12.												X	
TOTAL:				1									

EXPLANATION: "X"s indicate intersection of the same name, which is excluded from analysis. Each remaining square receives either a "1" (if the person is a source of information) or "0" (if they are not mentioned as a source of information). For example, the "1" noted in row 1, column 4, indicates that Theresa Trainor seeks advice from Cary Gaunt (CG). The opposite is true in the case of Kellie DuBay, who does not seek advice from Derrick McGinty (as indicated by the "0" in row 8, column 3). Note that spaces are left at the bottom of the table to fill in additional names as necessary.

Figure 12. An example of a social network matrix from Community, Culture and the Environment: A Guide to Understanding a Sense of Place (EPA, 2002).

Information gathering for Central Texas Greenprint for Growth

As a follow-up to the 2009 Central Texas Greenprint for Growth Report, Envision Central Texas planned a series of stakeholder events in each county to re-engage the participants and plan next steps. The events were designed to report Greenprint findings, the latest activities of the Greenprint Project, and discuss next steps and implementation strategies. I was invited to participate in the meetings to learn more about the process from the stakeholders who were involved in the multi-year Greenprint process. Three meetings were scheduled to bring together stakeholders from each county- Bastrop, Caldwell, and Hays. The first "Greenprint for Growth Stakeholder Meeting" was held in Bastrop County, on Oct 27, 2010. I also was invited to give an overview of the application of ecosystem services and discuss possible ways to integrate into the Greenprint process. "Greenprint for Growth Stakeholder Meetings" will also be held in Caldwell and Hays Counties in November, 2010 and December, 2010. I have been invited to participate in these meetings also- however that information will not be included in this report.

The Greenprint for Growth Stakeholder meetings will be held to gather input from stakeholders across the Central Texas Greenprint region, and to identify strategies for moving forward. Some strategies were identified during the Central Texas Greenprint process (2007-2009), and were identified in the report published in 2009. Since that time some strategies were initiated or implemented by various stakeholders; the collection of case studies and best practices was one such activity that has been lead by active

stakeholders. The result will be a series of published case studies that will illustrate strategy implementation and serve as templates for communities within the region that are contemplating similar measures. Additionally, a website will soon be launched that will provide access to the case studies and additional information highlighting Greenprint implementation strategies.

My continued participation Greenprint for Growth Stakeholder meetings will hopefully complement the on-going discussion about implementation strategies in the Central Texas Greenprint region. My participation in the initial exercise and meeting was two-fold: 1) to be an information source to participants about ecosystem services, and 2) to collect basic survey information from stakeholders about how they exchange information about ecosystem services and communicate information. First, I prepared and gave a brief presentation about ecosystem services and the potential integration with the Greenprint process. A copy of my presentation is included in Appendix A. Second, I led a participatory discussion about where we get information and data about ecosystem services in Bastrop County and how this could be used identify strategies for implementing ecosystem service planning.

Specifically, I developed and distributed a brief survey during the Greenprint for Growth Stakeholder meeting in Bastrop County (Appendix B). Approximately 35 stakeholders attended the meeting. I collected survey responses from 26 stakeholders. Stakeholders were asked about who they would talk to about the (ecosystem service) value of open

space in Bastrop County, and what information or data we need to value open space in Bastrop County for the stakeholder priorities of: ranching and farming, enhancing recreation, and water protection (quantity and quality). Stakeholders were allowed time to respond at the meeting, and were provided contact information in case follow-up questions or clarification was necessary. Survey responses ranged from complete to partial. Some returned with little or no identifying information.

The survey information will provide adequate preliminary information to begin a practitioner level social network mapping process. However, additional data would be necessary for a robust, quantitative assessment. As it stands, the survey results and participatory process will provide insights into the Bastrop County stakeholders understanding of ecosystem services and possible sources for collecting data about ecosystem services value.

Chapter Six: Results, outcomes, and conclusions

This study explores the potential for integrating ecosystem services into the Greenprint planning process, and the potential for social network analysis to inform the collaborative planning process. To do this, I reviewed and presented an overview of both ecosystem services and Greenprint processes with an eye toward understanding the areas of intersection. Greenprinting leads stakeholders along a process to first indentify community conservation priorities, and then produce a set of conservation priority maps based on an interactive, participatory process. An ecosystem service approach is a process that assesses a value, either qualitative-prioritized or monetized, for the beneficial functions that nature provides.

There is a two-fold connection between Greenprinting and an ecosystem service approach. First, Greenprint priorities can be defined in terms of ecosystem services, providing a framework for identifying ways to attribute value to the priorities and aligning potential strategies (such as funding) for conservation. Second, the interactive, community-based Greenprint process can involve stakeholders in the process of identifying and integrating ecosystem services into the conservation priority mapping, and assessing the potential value for conservation (either as a qualitative priority or as a monetized amount). Stakeholders can have a voice in both identifying the important values that nature provides, and finding the trusted sources for the information necessary to assess value. Social network analysis and mapping can be used as a method to

stimulate the collaborative process by evaluating and describing the communication methods and networking processes, and also to identify ways to strategically improve networks.

The planning methods of Greenprinting, ecosystem services, and social network mapping, all have a common link in that they are potentially valuable tools for developing a strong collaborative process for supporting land conservation efforts. Depending on the depth to which they are applied and the expected outcome the methods can provide qualitative or quantitative information. Each has a developing research methodology and theoretical basis that can lead to detailed analytical results. However each has a degree of uncertainty. The methods also require considerable resources and time for effective application. Each also can employ qualitative data collection methods such as focus groups, interviews and surveys to directly gain input from stakeholders and inform an interactive, participatory process.

The purpose of this report is to survey options for enhancing an ongoing participatory land use conservation effort: *the Central Texas Greenprint for Growth*. This is an exploration of possible implementation strategies, and an illustration of how the additional methods can be implemented within this Greenprint process. As an exploratory report, it stops short of a complete analysis of the processes or the in-depth development of quantitative research methodologies.

Additionally, the Greenprint process is interactive, participatory and collaborative. Outreach efforts are being conducted at this time, and the stakeholders are involved in the development of strategies for implementation and organizational design to support the next phases of the Greenprint process. To the extent that it will be useful to this continuing collaborative process, this report can provide background information and strategy suggestions for moving forward based upon work that has been done to implement ecosystem services, stakeholder involvement-social network mapping, and Greenprint programs in other regions. Additionally, this initial work will highlight the potential for work on this topic, both from an application and research perspective.

From this research, I suggest several strategies to integrate an ecosystem service approach into the Greenprint process. The Central Texas Greenprint for Growth process is entering the next phase of implementation. As such, discussion of implementation strategies is timely. The strategies for implementing of the Greenprint process to meet community land conservation priorities varies from among the other Greenprint programs, but we can learn from these activities as well as ecosystem service and social network method.

Strategies for integrating ecosystem services and Greenprinting

For each of the regional Greenprints that were reviewed for this report (Central Texas, Upper Nuese River, and Litchfield Hills), the priority conservation goals align with, or can be defined in terms of ecosystem services. The Greenprint conservation priorities selected through the participatory stakeholder process align with ecosystem services as classified by the Millennium Ecosystem Assessment. Table 4 is an evaluation and comparison of the Central Texas Greenprint priorities and ecosystem services. The first and second columns present the categories of ecosystem services and the ecosystem services as defined by the MEA (2005). The third column aligns the Central Texas Greenprint conservation priorities that were identified by stakeholders with the ecosystem services. By connecting the conservation priorities with ecosystem services, a process can be initiated to help find data, and identify organizations and data sources that will be necessary to evaluate the selected ecosystem services. This also shows that nature is a valuable part of our community infrastructure. These nature-based support services are sometimes also referred to as green-infrastructure. With the appropriate data, the value of the ecosystem services can be integrated into the mapping process. The conservation priorities, aligned ecosystem services, associated qualitative and quantitative data, and the enhanced Greenprint maps- when presented together, can be used to support local government strategic and comprehensive planning efforts. Green infrastructure can be considered in strategic planning.

Table 4. Comparison of ecosystem services and selected Greenprint priorities (author).

Ecosystem Service Category	**Ecosystem Service**	**Greenprint Goal**
Provisioning Services	Food	Ranching and farming
	Fresh water	Ranching and farming; Water protection
	Fuel/ wood	Ranching and farming
	Fiber	Ranching and farming
	Biochemicals	Ranching and farming
	Genetic Resources	Ranching and farming
Cultural Services	Recreation and ecotourism	Recreation
	Cultural heritage	Ranching and farming Recreation
	Educational	Recreation
	Aesthetic	Ranching and farming
	Spiritual and religious	Water quality
	Inspirational	Water quality
Regulating Services	Climate regulation	Ranching and farming
	Disease regulation	Water quality
	Water regulation	Ranching and farming; Water protection
	Water purification	Ranching and farming Water protection
	Pollination	Ranching and farming Parks and recreation
Supporting Services	Soil formation	Ranching and farming
	Nutrient cycling	Ranching and farming
	Primary production	Ranching and farming Water quality

Strategies for integrating Ecosystem Services and Greenprinting may include:

1) **Align the Greenprint conservation priorities with ecosystem services.** Stakeholders, through a collaborative process that takes into account the most critical community conservation issues, select the conservation priorities. Ecosystem services define the biophysical processes and benefits of ecosystems. This process strategically classifies the conservation priorities as specific measurable community benefits (Table 4).

2) **Identify data needs and possible data sources.** Like traditional infrastructure and community services, there are numerous methods for evaluating or valuing ecosystem services. When conservation priorities are defined as ecosystem services, steps can then be taken to identify the data necessary to assess value. For instance, greenways that have recreational value may be supported by: a) Community service standards that promote per capita goal; or b) Public health data that compares medical cost reduction and access to available open space and trails. A Greenprint research strategy can be developed to identify and collect data.

3) **Integrate ecosystem services into the Greenprint maps.** Available data can be converted to appropriated formats and presented as additional layers in the GIS

mapping process. For instance, open space appropriate for recreation could be defined by the preventative health value in dollars per acre or per mile of trail.

4) **Align ecosystem services with local and regional government strategic and comprehensive planning processes**. The enhanced Greenprint maps and data can be integrated into local government planning processes. Strategies can be developed with local government for communicating the values and participating in strategic planning processes. Participation in the on-going state water planning and environmental flows planning process for this region (Region K) and the Colorado and Lavaca River Basin, is an example of an opportunity to interact with a planning process. An environmental flows plan and water plan will be developed for the region, by the end of 2011 (http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/group.html). Greenprint and ecosystem service data could be made available to the Stakeholder and Science Advisory Committee meetings are being held. Overall projects from local scale to regional and state scale are evaluated for numerous criteria including, financial, economic, and environmental. Adding this data is a way to evaluate the positive benefits of ecological conservation rather than only the negative fiscal impacts of maintaining environmental standards. Workshops and training opportunities could be held with local government project planners and budget analysts that explored opportunities to include performance-based

measures based on Greenprinting and ecosystem services analysis, in the evaluation processes.

Limitations to these proposed strategies exist. As was discussed earlier, ecosystem services analysis requires considerable resources, attention to detail, and data that may not be readily available. Methods such as contingent valuation are based on survey data that can be expensive and difficult. The models for evaluating ecosystem services are developing and as yet are not standardized, or well known among planning practitioners. Yet even with these imperfections, a process to engage practitioners and make use of this knowledge is an improvement on current program planning and economic modeling processes. The uncertainties are on par with other economic modeling uncertainties in traditional project evaluation methods.

Strategies for stakeholder participation: social networks

By design, the Greenprint process is an interactive, community-based method for identifying conservation priorities. Participatory and collaborative planning activities such as the Greenprint process, can be enhanced by understanding the way information is communicated among community partners and stakeholders. Communication pathways and informal communication methods can be analyzed through social network mapping and analysis. Social network analysis is a method that can be used to see how stakeholders gather information about a specific aspect, such as ecosystem services.

Maps, figures, and matrices can be used to help identify ways to develop communication strategies that are effective for the community-based process.

Strategies for involving stakeholders in ecosystem service planning:

1) **Include stakeholders in the process to identify priority ecosystem services.** An additional step can be integrated into the Greenprint process that leads stakeholder to define conservation priorities as ecosystem services (table 4). Communication and awareness strategies can be implemented to provide information about ecosystem services and how to integrate into the Greenprint planning.

2) **Create a social network matrices and maps to identify priority stakeholders.** Social network analysis can be used to describe communication pathways and gaps in the communication process. The outcomes can be used to inform the networking activities to target specific groups and organizations. Tables 5, 6 and 7 illustrate the results of a preliminary social network exercise in Bastrop County.

3) **Use the social network process to identify data and sources of data.** A challenge to identifying the value of ecosystem services at the local level is the identification and collection of data. A social network analysis can be used to identify data sources in the same way as it is used to identify trusted organizations

and individuals. Tables 8, 9, and 10 illustrate the results of a preliminary exercise to identify data sources to support an ecosystem service analysis.

The social network matrices highlight the number of times respondents identify the various organizations. This information can be used to identify the partners that have the most connections and potential to communicate information about ecosystem services. The information also highlights potential gaps in the collaboration, if some of the commonly identified partners are not regular participants in stakeholder activities. A high priority should be placed on involving those organizations and partners that have multiple connections.

4) **Use the collaborative planning process and stakeholders to promote priorities, ecosystem services and values.** The stakeholders and collaborative network can promote ecosystem service planning process of green infrastructure by participating in local planning efforts.

Social network results

As a pilot analysis, social network data were collected from stakeholders on October 27 at the Central Texas Greenprint Stakeholder Meeting in Bastrop, Texas. The purpose of the meeting was to update and inform stakeholders from the region about the outcomes of the Greenprint analysis. The stakeholders were an informed group that previously took part in the Greenprinting process, and included representatives from local government, businesses, natural resource agencies, agricultural interests and therefore were interested

and involved in regional land conservation and open space activities. The group was introduced to the concept of ecosystem services and the possible integration with the Greenprinting process.

Stakeholders were asked in a questionnaire:

- Who would they talk to about the value of ranching and farming, water, and parks and recreational opportunities in Bastrop County (Tables 5, 6, and 7)?
- Were would they go to obtain data about the value of ranching and farming, water, and parks and recreational opportunities in Bastrop County (Tables 8, 9, and 10)?

Twenty-six responses were returned, with partial information for some responses. Identifying information was minimal, and was not used in the analysis. While more complete data would be needed for a rigorous social network analysis, the data can be used to begin to understand how social network analysis can be applied. Individual responses were coded with a letter. Blank responses were indicated with an N/A. Respondents were asked to write in responses. Responses were categorized and listed as indicated along the top of each table.

The responses indicate network components or communication nodes as both specific organizations and general categories of stakeholders. Due to time constraints, analysis of the results is not complete. However, the matrices can be used to inform future

participatory planning efforts and stakeholder communication. Next steps should include a comparison of the identified stakeholder groups with the current active stakeholders. This analysis will reveal gaps in the stakeholder group makeup and can indicate individuals or organizations that should be included in future discussions about ecosystem services and Greenprinting. Tables 8, 9 and 10 can be used to develop a research agenda and identify sources for collecting data to inform an ecosystem service analysis of the region. Also, social network maps can be developed to graphically indicate key connections and communication networks. The categories with multiple responses indicated key components of a social network. Collaborative planning techniques and social network mapping have been used in watershed planning, habitat plans, forest resource plans, and other environmental and natural resource planning activities. The success of such applications is due in at least part, the amount of resources devoted and to the willingness of the regulatory agencies to allow a community-based program to set management objectives and goals.

With additional research, perhaps through direct interviews or focus groups, additional data can be obtained, and advanced social network analysis can reveal additional information about the stakeholder communications. Computer-based programs such as UCINET (http://www.analytictech.com/ucinet/) can be used for additional analysis.

Strategies: Lessons from other Greenprint Plans

Greenprints across the country have been used to implement land conservation strategies and practices. The strategic framework of the Greenprint has allowed communities to identify priorities, develop measurable goals and targets, and communicate outcomes. The two case illustrations used in this report, implemented different stakeholder structures, and addressed different community priorities. Each promoted unique strategies that resulted in progress toward their goals. Some of the strategies identified from a look at other regional Greenprints include:

1) **Identify and link to community priorities.** As an example, growth in the Nuese River watershed is dependent upon maintaining drinking water quality, and is a high priority among numerous sectors in the region. Water quality was therefore the primary strategic priority for Greenprint activity and has the potential to integrate various local planning efforts and create synergy between partners.

2) **Build a strategic collaborative.** The Litchfield Hills Greenprint Collaborative brought together 30 local land trusts in a common effort. The Greenprint Collaborative serves a valuable function for the local land trusts by providing administrative and technical support for obtaining land trust certification. The certification process is important for land trusts and funders for assuring long-term accountability. By serving as a resource the Greenprint Collaboration can assist the local land trusts while collaboratively working toward common

priorities. Preliminary social network matrices for the Central Texas Greenprint, Bastrop Stakeholder Group, may identify additional partners for a strong collaborative.

3) **Identify location specific funding sources.** Water quality funding sources became the primary support mechanism for the Upper Neuse Greenprint. Municipal and agency funding could be used strategically through the Greenprint partners to achieve goals that the local governments could not achieve alone. Individual landowners and philanthropic sources were the primary funding mechanism for the Litchfield Hills Greenprint Collaborative. Connections to local water planning initiatives and the Texas Water Plan and environmental flows process (http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows) may be one way to connect with additional resources.

4) **Connect with infrastructure planning.** In all three Greenprints reviewed, efforts are being made to connect the Greenprint planning process to the local and regional strategic, comprehensive, transportation, environmental, and open space planning activities. The addition of ecosystem service data can enhance even further the ability to influence local planning efforts and communicate the importance of green infrastructure.

Social network matrices

The following tables (5,6, and 7) were developed using information collected via a questionnaire at a Central Texas Greenprint Stakeholder meeting in Bastrop Texas. Attendees were asked to identify the people or organizations they would turn to know more about the value of ecosystem services related to the conservation priorities (recreation and parks, water quality and quantity, and ranching and farming). Tables 8, 9, and 10 contain responses to questions about the type and sources of data that would be required to determine value for the conservation priorities (recreation and parks, water quality and quantity, and ranching and farming). This preliminary social network matrix data can be used to develop a social network map, to further analyze the social network, and to develop communication strategies among Greenprint stakeholders in Bastrop, Texas.

Respondent responses are recorded with an "X", with some respondents providing multiple responses. The totals for each response are recorded at the bottom of each column.

Respondent	Texas Parks and Wildlife	LCRA	Environmental Stewardship (non-profit)	Bastrop and other City / County	Outfitters – Canoes	Local Land Trusts- Land and Prairie Trust	Texas Master Naturalists	Bastrop State Park	Texas General Land Office
A	X								
B	X	X	X	X					
C		X			X				
D			X	X		X	X		
E		X							
F				X				X	
G				X					
H - N/A									
I		X		X				X	
J				X					
K	X			X				X	
L	X	X		X					X
M		X		X					
N	X								
O	X			X					
P	X			X				X	
Q-N/A									
R				X					
S									
T				X					
Total Responses: 18	7	6	2	13	1	1	1	4	1

Table 5. Recreation-Who do you ask?

Respondent	Local Businesses	Community Members and User groups	Environmental Groups: Sierra Club	Chamber of Commerce	Economic Development Corporation	County Open Space, Parks, and Rec. Advisory Board
A						
B						
C						
D						
E						
F						
G						
H - N/A						
I						
J						
K						
L						
M	X	X	X			
N						
O				X		
P				X		
Q-N/A						
R				X		
S				X	X	
T						X
Total Responses: 18	1	1	1	4	1	1

Table 5 (continued). Recreation-Who do you ask?

Respondent	Texas Commission on Environmental Quality	Lower Colorado River Authority	NRCS	Pines and Praries Land Trust	Lost Pines Groundwater Conservation District	Envision Central Texas	Environmental Stewardship (consultant)	Texas Master Naturalists
A	X	X	X					
B		X		X	X			
C		X						
D						X	X	X
E					X			
F		X						
G								
H - N/A								
I	X						X	
J					X		X	
K								
L	X	X					X	
M	X	X			X			
N					X			
O					X			
P		X			X			
Q					X			
R					X			
S					X			
T	X	X						
Total Responses: 19	5	8	1	1	10	1	4	1

Table 6. Water-Who do you ask?

Respondent	Local Landowners	Aqua Water Supply Company	Bastrop Water and Wastewater	Texas Parks and Wildlife	Lower Colorado Regional Water Planning Group - Region K	Texas General Land Office	Army Corp of Engineers
A							
B							
C							
D							
E	X						
F		X					
G			X				
H - N/A							
I				X			
J					X		
K		X	X				
L						X	X
M			X				
N							
O		X	X				
P		X					
Q							
R							
S							
T							
Total Responses: 19	1	4	4	1	1	1	1

Table 6 (continued). Water-Who do you ask?

Respondent	American Farmland Trust	AgriLife Agricultural Extension Service	NRCS	Local Soil and Water Conservation Board	LCRA	Local Farmers and Organic Farmers	Farmers Market/ Bastrop Market	Local Land Owners and Ranchers	Economic Development Agencies/ Corporations
A	X	X							
B			X	X	X				
C						X	X	X	
D		X							X
E						X			
F									
G									
H									
I		X							
J								X	
K							X		
L		X			X				
M						X	X	X	
N								X	
O		X							X
P								X	
Q						X			
R		X							
S		X							
T									
Total Responses: 19	1	7	1	1	2	4	3	5	2

Table 7. Ranch and Farm-Who do you ask?

Respondent	CAPCO	Bastrop County Commissioners	Farm Bureau	Board of Realtors/ Realtors	Appraisal Office	Trust for Public Land	Texas General Land Office	Local Land Trusts	Texas Department of Agriculture
A									
B									
C									
D	X	X							
E			X						
F				X					
G				X					
H					X				
I									
J									
K				X		X			
L							X		
M								X	X
N				X	X			X	
O				X					
P				X					
Q				X					
R									
S				X					
T									
Total Responses: 19	1	1	1	8	2	1	1	2	1

Table 7 (continued). Ranch and Farm-Who do you ask?

Respondent	Dollars spent on recreational activities	Access to recreation (number and types of sites available – river access)	Types of recreation activities	Historic Tourism (Historic Commission)	Dollars spent at camps (i.e. Scout camps)	TPWD Park economic impact	Visitor data (How far, travel distance)	Land value near recreation
A	X							
B		X						
C			X					
D	X			X				
E					X			
F (N/A)								
G (N/A)								
H (N/A)								
I						X		
J	X							
K								X
L	X						X	
M	X		X				X	
N (N/A)								
O						X		
P								
Q								
R (N/A)								
S						X		
T	X	X	X			X	X	
U (N/A)								
V		X						
W (N/A)								
Total Responses: 18	6	3	3	1	1	4	3	1

Table 8. Recreation-What data do we need?

Respondent	Potential income (market research)	Habitat value
A		
B		
C		
D		
E		
F (N/A)		
G (N/A)		
H (N/A)		
I		
J		
K		
L		
M		
N (N/A)		
O		
P	X	
Q		X
R (N/A)		
S		
T		
U (N/A)		
V		
W (N/A)		
Total Responses: 18	1	1

Table 8. Recreation (continued)-What data do we need?

Respondent	NCRS (soils and erosion data)	Impacts of crop type on water(use and quality)	Cost of water treatment/ protection	Cost of groundwater protection	Commercial and Municipal water use	Cost of water /Storm water treatment for developed land	Groundwater recharge rates	Value of water vs other natural resources (oil, minerals)
A	X	X						
B			X	X				
C			X		X			
D (N/A)								
E (N/A)								
F (N/A)								
G			X					
H (N/A)								
I			X					
J			X			X		
K			X					
L			X		X			
M					X		X	
N			X	X				
O			X	X				
P (N/A)								
Q (N/A)								
R				X				
S			X	X				
T								X
U (N/A)								
V			X					
W (N/A)								
Total Responses: 15	1	1	11	5	3	1	1	1

Table 9. Water -What data do we need?

Respondent	Cost of infrastructure (developed vs. open space)	Land Values /Appraisal Values	Farm and Ranch production ($)	Organic food production	Number of 100 year farms	Land productivity values (Texas Extension)	Land productivity values (NRCS)	User /Visitor information (types, numbers, users, $ spent)	Cost of water treatment (developed vs. open)
A	X								
B		X							
C			X	X					
D (N/A)									
E		X			X				
F (N/A)									
G		X							
H (N/A)									
I						X	X		
J (N/A)									
K	X								
L								X	
M			X	X				X	
N		X	X	X					
O		X							
P		X							
Q			X						X
R		X							
S		X							
T		X							
U (N/A)									
V						X	X	X	
W		X							
Total Responses: 18	2	10	4	3	1	2	2	3	1

Table 10. Ranching and farming -What data do we need?

Appendices

Appendix A: Questionnaire: Greenprint and Ecosystem Services; Bastrop

Appendix B: Power Point: Identifying value through the Greenprint process

Appendix A

Questionnaire: Greenprint and Ecosystem Services; Bastrop

Name: Affiliation:

E-mail/Phone number:

1) Who (organization and/or individual) do you talk to for information about the value of Bastrop County land for (who do you ask/trust):

   Ranching and Farming:

   Enhancing Recreation

   Water protection (quantity and quality)

2) What data do we need to understand the value of Bastrop County land (and where do you go to get it) for:

   Ranching and Farming

   Enhancing Recreation

Water protection (quantity and quality)

Appendix B: Power Point: Identifying value through the Greenprint process


Ecosystem Services
Identifying value through the Greenprint process
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Rob Borowski


A framework for regional land conservation and watershed planning
108


Question
Can an ecosystem service approach enhance our Greenprint planning effort?
109

Most current environmental laws measure impacts (cost).

An ecosystem service approach measures benefits (value).

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Ecosystem Services definitions

* **Ecosystem Services:**

  "Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being." Boyd and Banzhoff (2007)

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Characteristics of ecosystem services

- Meet human need
- Appropriate to scale: Regional (to global)
- Multi-dimensional: interdisciplinary / multi-media (air-land-water)
- Participatory: stakeholder / community -based
- Addresses sustainability
- Strategic: addresses priorities
- Performance-based : measures, evaluation, value

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What is measured

Provisioning services: the products obtained from ecosystems, including:

Food

Fresh water (supply)

Fuel and wood

Fiber

Genetic resources

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What is measured: Provisioning Service Examples

Water treatment costs are much less for watersheds with intact forests or vegetation. Costs increase 211%, when forest cover is reduced from 60% to 10%.

- How does open space protect our watershed (fresh water)?
- How much do our farms and ranches contribute to our economy (food)?

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What is measured

Cultural services: the non-material benefits people obtain from ecosystems through:

Recreation and ecotourism

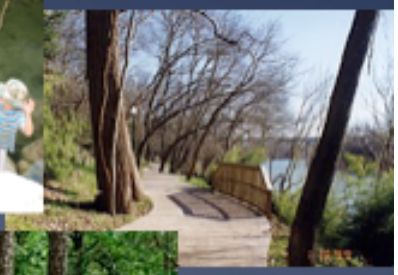
Culture and heritage

Educational

Aesthetic values and experience

Spiritual enrichment, religious

Inspirational



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What is measured: Cultural Service Examples

San Diego Convention and Visitors bureau estimates that overnight visitors spend $107/ person and day visitors spend $48/person—because of park. Total spending: $114 million per year.

* What is the value of parks, ranches and farms to tourism?
* What is the health benefit of parks, trails? (Active people save $250 on health care costs, active seniors save $500)

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What is measured

Regulating services: the benefits obtained from the regulation of ecosystem processes including the regulation of:

Climate

Water (flood protection, erosion, filtration, purification)

Some human diseases

What is measured

Supporting services: that are necessary for the production of all other ecosystem services. Some examples include:

Biomass production

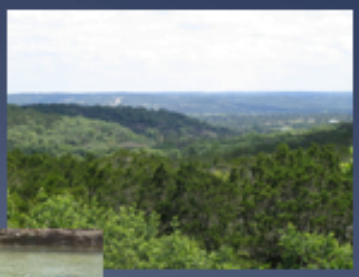
Production of atmospheric oxygen

Soil formation and retention

Nutrient cycling

Water cycling

Provisioning of habitat



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Greenprint Goals

Protect Water Quality and Quantity

Preserve Farms and Ranchlands

Enhance Recreation Opportunities

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Managing Collaboratively:
communicating and incorporating new information
How do we communicate?
Who do we talk to ?
How do we get information?
120

Measuring Ecosystem Services

1) Monitized

-Place a $ value

2) Identified, prioritized and strategic

-Would we miss this if it were gone?

-Would we have to build something to replace it?

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Questions 1

- Who do you talk to for information (who do you ask/trust) about the value of Bastrop County land for:

  Ranching and Farming

  Enhancing Recreation

  Water protection (quantity and quality

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Question 2

- What data do we need to understand the value of Bastrop County land (and where do we go to get it) for:
  - Ranching and Farming
  - Enhancing Recreation
  - Water protection (quantity and quality)

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Ecosystem Service Category	Ecosystem Service	Greenprint Goal	Who do we talk to?	What data/Where?
Provisioning Services	Food	Ranch. and farm		
	Fresh water	Ranch. and farm; Water protection		
	Fuel/ wood	Ranch. and farm		
	Fiber	Ranch. and farm		
	Biochemicals			
	Genetic Resources			
Cultural Services	Recreation and ecotourism	Recreation		
	Cultural heritage	Ranch. and farm		
	Educational	Recreation		
	Aesthetic	Ranch. and farm		
	Spiritual and religious			
	Inspirational			
Regulating Services	Climate regulation	Ranch. and farm		
	Disease regulation			
	Water regulation	Ranch. and farm; Water protection		
	Water purification	Ranch. and farm Water protection		
	Pollination			
Supporting Services	Soil formation	Ranch. and farm		
	Nutrient cycling	Ranch. and farm		
	Primary production			

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How will this be used? What's the goal?

1) Learn from other Greenprint programs:
   - what are they doing now?
   - do they consider ecosystem services?
2) Suggest ways integrate ecosystem services into the Greenprint and measure value
3) Learn how we communicate important information about the Greenprint and ecosystem services

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